
UNDERSTANDING UNIVERSITY-SOCIETY ENGAGEMENT FOR INNOVATION

The role of individual actors in institutionalizing the regenerative medicine
research field in University of Tampere (Finland), 1986-2017



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Abstract

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In the rapidly changing higher education landscape, there is a need to understand the role of academics in institutionalization process of a divergent change, including academia's engagement with industry and society, which many universities worldwide are now confronting with. The purpose of this organizational level study was to understand a divergent change of emergence and institutionalization of an applied field of regenerative medicine research in University of Tampere, a university focused on basic research, as a bottom-up process in which the role of individual academics was of key importance.

To meet the research purpose, this dissertation mainly relied on semi-structured interviews of twelve academics and managers followed by a brief quantitative survey. To analyze the qualitative data, a theoretical frameworks was synthesized employing the key concepts, such as institutional enablements and constraints, the human agency, and projective imaginations of actors, their internal conversations, social positions, and strategies.

This research has identified four academics who played the key role in the face of institutional constraints, including skepticism, conflicting expectation on researchers, the low institutional support to bring the change, and the silos of academic community of Tampere. Two of these institutional entrepreneurs had no formal social position, but due to their vision, passion, curiosity, societal commitment and engagement, and past work experience played key role in the beginning phase. The other two who came in the second and third phases were effective due to their strong leadership qualities, formal social positions, and contextual discontinuity.

The main conclusion drawn from this study is that in the face of institutional constraints and the opposition from the research superstars, the change was to a great extent non-deterministic in nature which would have been difficult, especially in the beginning phase, without some institutional entrepreneurs.

This research has argued that for making Finnish universities globally competitive but locally engaged, it is essential for universities to protect people who value societal engagement, provide high level trainings to develop visionary leadership, and hire people who have work experience in other countries and other sectors of economy. At the personal level, this research has suggested that in spite of institutional barriers, academics can achieve their valued goals, if they have vision, passion, and commitments.

Dedicated to my mother, wife, and kids

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List of Abbreviation

<i>Abbreviation</i>	<i>Explanation</i>
BMT	BioMediTech
CRC	Cell Research Center
FICAM	Finnish Centre of Alternative Methods
IMT	Institute of Medical Technology
TAMK	Tampere University of Applied Sciences
TAU	Tel Aviv University
TEKES	The Finnish Funding Agency for Technology and Innovation
TUT	Tampere University of Technology
UTA	University of Tampere

1 Introduction

Worldwide higher education is going through massive reforms. Mostly these reforms are driven by the massification of higher education, the emergence of the knowledge economy, budget cuts in education due to worldwide financial crises, and spread of neo-liberal ideologies (Torres, 2011). Neo-liberal ideology proposes a minimum role of the government in education and see the purpose of higher education as the development of human capital only which is essential for economy (Friedman, 1955). These reforms have defined universities as engine of economic growth only and are driven by priorities set by business and industry. As the public support for higher education is declining, the reforms have pressured public universities to focus on ‘efficiency and accountability’, ‘privatization’ and ‘international competitiveness’ (Torres, 2011; Van Vught, 2009). Many Universities and University Associations or Rector Conferences, as they are called in some European Countries, now regularly publish studies of their impact on local, regional and continental level to influence the policy makers and funding bodies (Economics, 2015; Universities, 2014, 2015). The reforms have effects at various levels. At institutional level, universities are now competing for shrinking funds and finding alternative sources of funding, including increasing tuition fee. At the micro level, the academics feel that “the only things that count are the things that can be counted”, noted by Margaret Archer (Gonzales, 2015, p.317).

Van Vught (2009) has further noted that knowledge is now considered as a strategic factor of production. Knowledge when transformed into innovation can create competitive advantage of a country and region. In the knowledge economy, higher education and research are important arenas for knowledge production and innovation; thus they are considered as important players in combating the economic crises, promoting growth, and developing highly skilled human capital (Van Vught, 2009). As the expectations are changing, universities have to rethink their mission, internal processes, and their role and impact on economy and society. Most of the aforementioned changes can be called as divergent change, “*a change that breaks with the institutionalized template for organizing within a given institutional context*”. Many elite universities have already adopted an entrepreneurial approach, others are also revisiting their approaches or trying to imitate the elite (Etzkowitz, 2014). Entrepreneurial universities actively engage with industry and businesses for transferring explicit and tacit knowledge for addressing societal challenges. Universities now have to cater the demands of industry, students and governments (Clark, 1998a; Etzkowitz, 2014).

New modes of knowledge production have also emerged. Campbell (2006) has described three modes of knowledge production, namely mode 1, mode 2, and Triple Helix System (THS). The Triple helix model has been proposed by Etzkowitz and Leydesdorff (2000). This model has been getting prominence and is comprised of three helices: state, academia, and industry. According to OECD’s sectoral classification, the state can be government, academia can be higher education institutions and industry is businesses. These helices interact in different ways. In a strong state, government manages academia and industry. While in a laissez-faire system, each helix work and develop independent of each other. Finally, in a system of trilateral network and hybrid organization, the three helices overlap and frequently interact with each other and can even lead to hybrid organizations. When interaction amongst these helices is increased beyond a certain point, the knowledge economy is developed.

In Europe, European Union is the key actor in strengthening knowledge economy. It has started many programs to promote research and innovation for enhancing European competitive advantage

and to solve many societal problems. These programs are changing European higher education and research landscape. Some of these programs include Framework Programs, Horizon2020, European Research Area(ERA), Erasmus+, and European Institute of Innovation and Technology(EIT). EIT is established on the concept of Triple Helix and is encouraging the universities, R & D organizations, businesses, and governments to join hands for research in applied and interdisciplinary areas (EIT, 2011).

These programs are top-down approaches and are designed on the view that there is an optimal configuration of institutions for knowledge generation, diffusion and valorization. According to Grillitsch and Trippl (2014), geographic proximity and region-specific cultural and institutional context facilitate exchange of knowledge(particularly tacit) between various actors and leads to innovation. In the top-down approach, governments focus on “*rules of the game*” such as “*intellectual property rights laws; other laws; various standards; environment, safety, and ethical regulations; industry specialization and structures; governance structure; financial systems; R & D structure; R & D investment systems; and training and competence building system*”(Sotarauta, 2016, p.6). However, for a nuanced understanding of knowledge transfer and innovation, it is important to study the role played by the individual actors in the constellation of various institutions when these actors try to achieve their various goals.

1.1 Problem Statement

In the contemporary higher education milieu, academics have very important position and role. In some instances, they are the change agent while in others they are the victims of the change. For instance, Miller, Alexander, Cunningham and Albats (2017) in a detailed literature review have noted that in the changing higher education landscape, the role of academics is very crucial for conditioning linkages of universities with industry and business in a meaningful way for contributing towards society and economy. They have further argued that the universities are now expected to become fully entrepreneurial. Clark (1998b) in his classic study of five European entrepreneurial universities reported that the emergence of entrepreneurial universities had been an important change during the last few decades. The change had been influenced by neo-liberal ideals. Entrepreneurial universities espouse market norms and strategies to achieve their missions. Gumpert (2008) has mentioned that Burton Clark had claimed that “*organizational transformation*” of five European universities towards “*entrepreneurial universities*” cannot be simply attributed to the leadership of those universities. Clark has rather “*featured the faculty members’ agency in the steering core and imbedding the entrepreneurialism in the “academic heartland” of basic organization structures of academic work*”.

Consequently, the role of academics is also changing. Miller et al. (2017) have further noted that traditionally the academics were responsible for teaching, research, publications, and some administrative task. The contemporary changes in higher education demand more active involvement of academics not only in basic and applied research, but also in knowledge transfer, commercialization of knowledge and innovation, and entrepreneurship. However, Cai (2015) has argued that “*the missions of universities are not confined to promoting economic growth but are also about transforming the institutional structure and introducing new values into society*” (p.18). In a similar vein, Goddard et al. (2013) have argued that the role of universities is not limited to economic development or technology innovation, but also includes other areas of social life, for instance,

public health, sustainable development, and arts and culture. The social responsibilities of the universities are now called as their 3rd mission.

Many of the above-mentioned changes have created “*tensions and dilemmas*” for the academics because their role and identities are changing due to conflicting expectations they are facing. Miller et al. (2017) have, therefore, indicated the need to investigate the approaches academics adopt to affect their institutional settings, resolve the ‘*tension and dilemmas*’ they confront, and overcome the restraints in legitimizing the knowledge transfer between university and industry in a changing context where many universities now aspire to become entrepreneurial universities.

Importance of individual actors can also be identified in many other changes when academics despise the change in order to safeguard their identities. Gonzales (2012) has reported “*mission creep*” as one of the impact of the neo-liberal reforms when universities abandon their original mission to serve students and society and start valuing those things which are important in rankings of the universities. To these top-down initiatives, she has outlined three important responses of faculty when they perceive that their universities are creeping the original mission. These responses include operationalizing, negotiation, and acquiescing. Similarly, in another study conducted in United States, Gonzales (2015) has indicated that in many comprehensive and teaching focused universities which are now striving to achieve national research status, academics assert their agency to disrupt those striving structures by *resisting*, *negotiating*, and *critiquing*. She has called these responses as “*mundane yet powerful*” acts of *human agency*¹.

These examples substantiate the argument that in the complex and conflicting institutional missions and expectations, actors within the institutions play important roles. Although they cannot be considered as fully autonomous, they do not blindly follow the institutions either. On the one hand their actions are conditioned by the institutions, while on the other hand, they also construct, institutions. The role of individual actors in the transformation and change of the institutions was first discussed by Selznick (1957) and then after a long pause by DiMaggio (1988) in his seminal work (Battilana, Leca & Boxenbaum, 2009). Individual or organizational actors who envision and implement a divergent change in an institution are called as *institutional entrepreneurs*. Bernard Leca, Battilana and Boxenbaum (2008) have noted that studies on institutional entrepreneurs are needed. However, Miller et al. (2017) have pointed out the scarcity of studies exploring the motivations of academics engaging in university-industry linkages for the transfer of knowledge.

Sotarauta (2016, p.1) has argued that the lack of focus on “*agency, intention, and interest, leaves regional innovation studies and studies focusing on knowledge dynamics at an overly abstract level*”. He has further noted that so far regional innovation studies have focused only on meso and macro level analysis and have missed the role of human agency at various levels. Thus “*there is a gap in our understanding of how actors cope with multi-layered, and therefore conflicting and complementary, institutions, and with mixed messages to be drawn from them*”. Further, these studies have not identified the link between human agency, at micro level, and the institutions at meso or

¹ Scott (2013) has simply defined human agency as “an actor’s ability to have some effect on the social world—altering the rules, relational ties, or distribution of resources.” (p.94). A more complex definition of human agency which is used in this thesis is given in section 2.6.

macro level. As a result, there is not sufficient “*basis for the construction of a theory of institutional agency*”.

As the institutions not only enable and constrain human actions but also depend upon them, therefore, Sotarauta (2016) has proposed that it is very essential to investigate institutions as well as agency to get a nuanced picture of dynamics of change in innovation studies. He has further proposed that “*there is a need to anchor a role for [human] agency in institutionally oriented regional innovation studies, and thus to reach beyond snapshots of top-down institutions, and to produce a more nuanced view on institutions bottom up*”. Innovation studies should explore the role of individuals across multiple institutional boundaries in rallying support of disparate actors in combining their knowledge, competencies and resources. Consequently, he has also warned to avoid methodological individualism, where researchers, assuming the individuals as sole change agents, focus on day-to-day activities of specific actors and “*overly detailed accounts of actors’ behavior without a proper understanding of how they relate to institutions and the main issues of economic development*”. There is also a need to study the institutional entrepreneurship “*as a multi-actor, multi-scalar, and multi-locational phenomenon in time to be able to identify and analyze the evolution, main events, and especially the critical incidents of the cases under scrutiny*”. He has proposed that the bottom-up approach in the “*concepts of institutional entrepreneurship and institutional navigation*” can help bridge the gap in understanding the institutional change. Consequently, it is essential to understand the intentions and strategies of the actors, and “*the ways they come together or into conflict with institutional arrangements*”. He has argued that “*global knowledge flows are built on the intentions of actors. Intention refers to determination of an actor or group of actors to: (a) act in a certain way, and (b) achieve something or to produce predefined effects on something*”. He has thus noted that it is important to provide central place to the intentions, strategies, and social position of actors in the studies investigating innovations. (Sotarauta, 2016). Hodgson (2007, p.3) has argued that “*very few social scientists would deny the role of individual intentions in the explanation of social phenomena*”. Moreover, according to Archer (2000) understanding commitments, emotions and passions is also important for studying human agency (Gonzales, 2015).

These examples underscore the importance of actors in the change process in higher education and innovation studies. Thus, there is a strong need to investigate how individual actors play their role in a change process in higher education, for instance, establishing a new program, establishing a new research field, promoting linkages between academia and industry, developing cooperation between various academic institutions, and addressing societal needs. For investigating academics’ role in the change process, it is not only essential to give due weightage to the institutional constraints or enablements, but also essential to study academics’ intentions, identities, entrepreneurial and psychological characteristics, and other ‘*individual value drivers*’.

For this thesis, a case study of emergence of a *field of regenerative medicine research* in Tampere (Finland) during 1986-2017 is chosen to investigate the role individual academics in promoting and institutionalizing the new research field. Emergence of regenerative medicine research field in Tampere is a divergent change in the regional innovative system in general and the University of Tampere (UTA) in particular, because it required many institutional changes. Many scholars have reported that since the beginning, the academics in UTA were focused on academic excellence. While the new field of regenerative medicine was an applied research field which required extensive linkages with the practitioners. Consequently, its exponent faced many challenges and its institutionalization required many changes in the regulatory, normative, and cultural-cognitive

pillars of the University and of the regional innovation system, if the “*omnibus*” institutional model of Scott (2013) is used for defining institutions.

1.2 The Research Purpose & Research Question

The purpose of this organizational level case study is to understand institutionalization of regenerative medicine² research field in University of Tampere as a bottom-up process in which the role of individual academics was of key importance. At this stage in the research, institutionalization can be defined as “*as a process...that happens to an organization over time, reflecting the organization's own distinctive history, the people who have been in it, the groups it embodies and the vested interests they have created, and the way it has adapted to its environment*” (Scott, 2013, p.24).

This study is driven by the following central question:

1. How did some academics play a key role in introducing and institutionalizing the regenerative medicine research field in the University of Tampere from 1986 to 2017?

Following are sub questions:

- i. How did the regenerative medicine research field emerge in Tampere, 1986-2017?
- ii. What were the institutional structures which were constraining the choices(human agency) of the academics trying to institutionalize regenerative medicine field in Tampere?
- iii. What were the institutional factors which were enabling the choices(human agency) of the academics trying to institutionalize regenerative medicine field in Tampere?
- iv. What were the motivations(rational choice, commitment, identity, passion, emotion etc.) of the key academics in promoting and institutionalizing the new field?
- v. How actors’ projective imaginations, internal conversation, past histories(such as past work experience), and social positions helped them to navigate the social structures for institutionalizing the regenerative medicine research field in Tampere?
- vi. What were the strategies which the key actors adopted for promoting and institutionalizing the new research field?
- vii. To what extent regenerative medicine research field has been institutionalized in UTA?

1.3 Significance of the Study

As higher education sector is going through massive transition worldwide, many of the changes being introduced fall in the category of a divergent change. For instance, increased focus on internationalization, developing linkages between academia and businesses, ensuring students’ employability, tapping new sources of income including capitalizing on alumni, and quality management and enhancement. Similarly, many higher education institutes or systems have to adopt the divergent changes to be competitive and to meet the new expectations of various stakeholders. For the successful implementation of these changes, it is not only required to develop meso and

² Regenerative medicine is a sub area in cell and tissue engineering research field. However, in this study these two terms are used interchangeably.

macro level strategies and policies (top-down processes), but also important to understand how the individual academics, managers, or Rectors make their personal choices and strategies to play an effective role in introducing and institutionalizing the change (the bottom-up processes). Similarly, it is also important to understand faculty's response to the divergent changes.

This micro level study accounting for academics' agency in institutionalizing an emerging field of regenerative medicine in Tampere(Finland) can explain the individual level factors and strategies in promoting and institutionalizing the change. It can also shed light on challenges of establishing an applied research field in a university focused on basic research. It can deepen the understanding of forming of academia-academia linkages, engagement of academia with society and regional government, the challenges associated with promoting the so called 3rd mission of European universities, and the challenges associated with commercialization efforts of many universities.

These findings can not only be utilized in higher education, but also in any other sector. Battilana et al. (2009) have argued that understanding the role of institutional entrepreneurs is very important in the era when many governments and economies are facing the challenge to reform the institutions for the economic revival. In the context of declining public funding for higher education, it is essential for faculty to play significant role not only to achieve their institutional goals but also to contribute in the national economy. In the European context, successful realization of the European higher education modernization agenda, especially when in many European countries higher education funding from public sources is going down (EUA, 2017), the role of academics has become increasingly important. This research can help actors, such as university administrators, policy makers, and faculty to understand the institutional reform processes. Research on institutional entrepreneurship can also be utilized for improving social welfare and training of actors for positive change.

Sotarauta (2016) has argued that the bottom-up innovation studies focusing on human agency can "*change our view on what institutions actually are and what not*". It can also add to the understanding on the impact of institutions.

This research is specifically important for Finland and Europe in general, but also important for other countries. For instance, in Pakistan Higher Education Commission(HEC) has invested generous funds since 2002 for developing new faculty and promoting research to uplift the higher education. Thousands of young people were sent to different European universities to pursue master and PhDs (Husnain, 2014). However, on their return, they have been facing difficult circumstances as the senior faculty and administration has not got foreign trainings. Some old faculty are resistant to change. So, the young faculty is not as productive as they could be in a bonhomie and supportive environment (Khan & Jabeen, 2011; Tahir, 2016). It is, therefore, important for the young faculty to learn how to exercise their agency for promoting their innovative ideas and projects.

1.4 Outline of the Chapters

This thesis is organized as follows. The next chapter – Literature Review – examines the literature relevant to the purpose and questions of this research, beginning with the definitions of the important terms. Then an exhaustive review of the literature is presented on different topics, such as institutional entrepreneurship, academic entrepreneurship, entrepreneurial academics, critical realism, internal conversation, and agentic orientations. In addition, the theoretical framework which

is used for the data collection and analysis is also described in this chapter. In *chapter three*, research methodology is explained, which is case study. In *chapter four*, the case of emergence of regenerative medicine research at University of Tampere is described chronologically using the qualitative and quantitative data collected during this research. In *chapter five*, data has been analyzed using the theoretical framework presented in *chapter two*. In this chapter important institutional constraints and enablements are discussed first in section 5.1 and 5.2 respectively. Acts and sources of human agency are discussed in 5.3. In the next two sections, actors position and their strategies are discussed. In section 5.6, various changes which have taken place during last two decades in the three pillars of the institution are discussed. Then In the *final chapter*, conclusions of the study and the recommendations for practice and further study are given. In this chapter, the researcher's own reflection and the limitation of this research are also given.

2 Literature Review

This chapter has discussed the literature relevant to the purpose statement and research questions of this thesis. It starts with the basic concepts about social structures, institutions, organizations, institutionalism, and new-institutionalism. After this basic introduction, enabling conditions, which an institution can offer for institutional entrepreneurship are discussed in section 2.3. Various scholars have explained the process of institutional entrepreneurship which is given in section 2.4. Two important types of entrepreneurs often found in universities are entrepreneurial academics and academic entrepreneurs. The difference between these two types of academics is discussed in section 2.5. In section 2.6, three different types of conceptual framework and their relevance for this research are explained. Finally, a synthesized framework is discussed in 2.7. This framework is comprised of elements taken from the three frameworks discussed in section 2.6.

2.1 Introduction to Institutions

In social sciences *social structures*, *institutions*, and *organizations* are important concepts which have important implications for this research. Therefore, these terms are first defined here. *Social structures*, or sometime simply called as *Structures*, are “all sets of social relations, including the episodic and those without rules, as well as social institutions”. *Institutions* are special type of social structures or a sub-set of social structures. Not every social structure can be an institution; for example, demographic structure is a social structure that is not an institution. Scholars have defined institutions differently. For Hodgson (2006, p.2) institutions are “*systems of established and prevalent social rules that structure social interactions*”. Examples of institutions are “*language, money, law, systems of weights and measures, table manners, firms, and other organizations*”. On the other hand organizations are special types of institutions or a sub-set of institutions. An institution can be regarded as an organization if it has the criteria to establish its boundaries and to distinguish its members from non-members. Furthermore, it must have “*principles of sovereignty concerning who is in charge*”, and a chain of command for deciding role and responsibilities within the organization. Thus organizations can be described as bounded institutions. A business firm is simultaneously a *social structure*, an *institution*, and an *organization*. While language is an example of institution which is not an organization. (Hodgson, 2007, p.96).

March and Olsen (2006) have further elaborated institutions as “*a relatively enduring collection of rules and organized practices, embedded in structures of meaning and resources that are relatively invariant in the face of turnover of individuals and relatively resilient to the idiosyncratic preferences and expectations of individuals and changing external circumstances*” (p.1). In this definition, the role of individual is also delineated. Institution is a very contested concept in different disciplines, such as economics, political science, sociology, cognitive psychology, and cultural anthropology. Neo Institutionalists have defined institutions and their relationship with the various actors within them differently.

For institutional analysis, Scott (2013) has proposed an “*omnibus conception of institutions*” which incorporates various disciplinary concepts. For him, “*institutions comprise regulative, normative, and cultural-cognitive elements that with associated activities and resources, provide stability and meaning to social life*”(p.56). In Appendix 1, the three institutional pillars are shown along with the seven principle dimensions on which they differ. These dimensions include, for instance, the basis of compliance, basis of order, mechanisms of control, institutional logic, empirical indicators, basis

of legitimacy, and effect of compliance or non-compliance on the actors within them. These three pillars can be taken as a continuum, *“from the conscious to the unconscious, from the legally enforced to the taken-for-granted”* (Scott, 2013, p.59). Scott (2013) has argued that most of the institutions have all the three elements, but in some cases one or the other pillar gets preference over the others to support the social order. When the three pillars are in congruence, their effect is very strong and *“overdetermined”*. Many scholars have underscored the role of institutions to enable or constrain the behavior of the actors. They constrain behavior by sanctions, pressures for conformity, but they also enable behaviors by providing resources, reward, and legitimacy (DiMaggio & Powell, 1983; Hodgson, 2006, 2007). DiMaggio and Powell (1983) have identified coercive, normative, and mimetic mechanisms which promote of isomorphism in an organizational field. They have described isomorphism as *“a constraining process where organizations become increasingly alike to others that face the same set of environmental conditions”*. These mechanism highlight the deterministic behavior in an institutionalized field. Scott (2013) has noted that contrary to psychologists, sociologists have been giving high value to the contextual factors of the individuals. These sociologists think that human beings merely respond without any reflection to the social structures in which they live(p.44). For more than two decades, neo-institutional theorists were focused on the mimetic processes through which institutional actors reproduce the institutions within an organizational field. An organizational field can be defined as *“communities of organizations that partake of a common meaning system and whose participants interact more frequently and fatefully with one another than with actors outside of the field”* Kitchener and Leca (2010, p.135). These ideas had developed a deterministic view of the individuals.

Burke and Reitzes (1981) have challenged the deterministic views by emphasizing the role of human actor’s identity and reflexivity in creating, sustaining, and changing the social structures(Scott, 2013, p.44). Scott (2013) has emphasized that when the regulative, normative, and cognitive pillars of an institution are not aligned, they provide *“resources that different actors can employ for different ends”*. This situation creates confusion and conflicts and can lead to institutional change (p.71). Honneth (1996) explaining his ideas on social recognition, notes that normative approach better explains the motivations for resistance and change because it takes into account the identity and thus *“highlights the emotional grounds of action, in particular, the suffering that arises from disrespect and the moral insights that it generates: ‘In the context of the emotional responses associated with shame, the experience of being disrespected can become the motivational impetus for a struggle for recognition’”*McNay (2008, p.274). Scott (2013) has indicated that in social life emotions are the most important motivational elements. Scholars who have investigated “identity” and “institutional work” have studied the effect of emotions in social life. This work underscore the importance of human agency in *“in maintaining or changing the institutions”*. Conflicting demands at the macro level create conflicting role demands and issues of identity at the micro level which incite emotions. These emotions *“operate to motivate actors to change institutions in which they have become disinvested or to defend institutions to which they are attached”* (p.63). Different types of emotions are engendered when individuals confront with different institutional elements. For instance, in the case of regulatory institution that is constituted by rules which are implemented by the enforcement machinery, “fear, dread, and guilt” can arise as a result of non-compliance and “relief, innocence, and vindication” can result in the face of compliance. In the case of normative institutions, the resulting emotions can be honor and respect when actors comply to the institutions and shame or disgrace when they fail to comply. Finally, in the case of cultural-cognitive institutions, actors feel confident or certain when they comply and feel confusion or disorientation when they don’t comply. Alignment with the cultural beliefs make them feel “competent and connected” while in the case of

non-alignment they are called as “clueless” or “crazy” (Scott, 2013, p.70). Focus on these emotional responses underscores the need to study the micro level individual and interpersonal roles, because strong emotions motivate the actors to strive for institutional persistence or change, as Scott has noted.

2.2 Institutional Change

Honneth (1996) has argued that in classical sociology different scholars have not given due consideration to the human agency in describing social change. For instance, Durkheim or Parson explained social change as a result of “long-term structural tendencies”, Weber considered social change as individual or group struggle for power, Marx explained change as the result of objective inequalities. As a result, they have downgraded the emotional aspects of human suffering that can cause social conflict and change (McNay, 2008, p.274). Thus, in social or institutional change role of individuals can be significant due to their emotions or identity related problems.

Scott (2013) notes that institutional change can be incremental, or revolutionary. The impetus for change can be endogenous as well as exogenous. In addition, institutions represent not only a state of a social order *“but also institution as process, including the processes of institutionalization and deinstitutionalization”* (p.58). Hodgson (2006, p.7) has indicated that institutions as social structures act *“to some degree upon the habits of thought and action”* of the individuals. But that *“does not mean that institutions directly, entirely, or uniformly determine individual aspirations”*.

Although there were some examples from within the early work of neo-institutionalist on the accepting the role of human agency, but subsequent work merely focused on exogenous explanation or the external jolts as the determinants of change in institutions in a given field. Thus, they overlooked the role of human agency. Battilana et al. (2009) have noted that early institutional theorist considered only the constraints under which different actors worked. Thus human nature was assumed to be *deterministic* in early writings of neo-institutionalists, as role of institutions was considered as more important. Scott (2013) has raised many important questions regarding the sources of emergence of new institutions and change in the existing institutions, especially the actors and mechanisms of change. He has argued that institutional construction and change can be of two types: *naturalistic* and *agent based*. In naturalistic view, institutionalization process occurs not because of purposeful actions of rational actors, but as an unconscious behavior of actors who are facing similar problem. In solving these problems and in a process of collective sense making, they create institutions.

In agent-based view, agents or actors are important, because new institutions emerge or a change in the existing institutions occurs only through the intentional and self-interest based actions of certain actors. These actors may be individuals or organizations. For the first time, agent-based view was proposed by DiMaggio (1988) who investigated the endogenous explanation of the institutional change, i.e., in the agency of individual and organizational actors in the change process. He pointed out that *“institutional theory has no explicit or formal theory of the role that interests play in institutionalization and consequently defocalizes, or distracts attention from, the ways in which variation in the strategies and practices of goal-directed actors may be related to variation in organizational structures, practices, and forms”*. He thus noted that self-interest of actors and power processes can be easily ignored in highly institutionalized organizations; however, these factors can be easily identified during the process of institutional change and construction. He used the term *“institutional entrepreneurs”* for the actors who bring change in existing institutions. He further

emphasized that the “institutional theory must come to terms with interest and agency to a greater extent than it has thus far”.

Research on institutional entrepreneurship has played a key role in bringing human agency back as the main issue in institutional theory and thus has contributed to the evolutionary path of change discussed in institutional theory. Bernard Leca and Naccache (2006) have defined institutional entrepreneurs as “... organized actors who skillfully use institutional logics³ to create or change institutions, in order to realize an interest that they value highly. The selection of institutional logics will depend on the allies whose support is sought. Institutional entrepreneurs will use institutional logics that are likely to be valued by those potential allies, because they support their values and/or their interests”.

Bernard Leca et al. (2008) have noted that the number of articles on institutional entrepreneurship have exponentially increased since 1988. In their literature review of institutional entrepreneurship based on 67 articles, they have identified three major themes in the literature. First, how scholars have tried to reconcile the paradox of embedded agency, explained below. Second, what were the enabling conditions which helped institutional entrepreneurs, or their very emergence? Third, what was the process through which institutional entrepreneurship was materialized? Additionally, they also identified the different methods used for studying the institutional entrepreneurship.

Eisenstadt (1980) for the first time mentioned the term “institutional entrepreneurship” in his work. He argued that institutional entrepreneurs are organized actors with sufficient resources who seek to change the institutions when they see in this change “*an opportunity to realize interest that they value highly*” (Bernard Leca et al., 2008, p.3). Building on the work of Eisenstadt, DiMaggio (1988) extended the idea of institutional entrepreneurship. In early studies, researchers focused on the constraints under which actors were working, while the studies on institutional entrepreneurs focused on developing a theory of action within the tenants of institutional theory.

Research on institutional entrepreneurship has also shed light on the paradoxical concept of embedded agency where actors embedded in institutions strive to change their institutional settings. Without a rigorous theory of action, neo-institutional theory cannot explain the process of change in institutions. Thus, it is one of the weakness of neo-institutional theory. On the one hand, the concept of institutional entrepreneurship fills a void in neo-institutional theory, on the other hand it creates another challenge for this theory. This challenge is known as structure versus agency debate which means actors can disengage themselves from the structure or the context and take actions to change it. Heugens and Lander (2009) have noted that *structure* versus *agency* debate is the one the main dispute amongst institutional theorists. Holm (1995) has described this situation as ‘*paradox of embedded agency*’, meaning if the actors’ intention, actions, and rationality are conditioned by the institutions then how can they change those institutions. If the belief and actions of the individuals and the organizations are determined by the environment, how can they (individuals and organizations) can innovate. These questions indicated the tension between voluntarism and institutional determinism. Reconciling this ‘*paradox of embedded agency*’ is the biggest challenge

³ Institutional logics are “defined as central logics that supply principles of organization and legitimacy. Institutional logics are frameworks that incorporate the assumptions, beliefs, and rules through which individuals organize time and space, and which give meaning to their social reality” (Bernard Leca & Naccache, 2006, p.632).

in the development of coherent theory of institutional entrepreneurship within the tenets of institutional theory.

Battilana et al. (2009) have also indicated that though institutional theorists have adopted a theory of action and have acknowledged the role of agency and interests in organizational change, yet one obstacle to legitimizing this role is the “*paradox of embedded agency*”. It refers to the conflict between two views on agency in institutional theory. According to one view, institutional entrepreneurship are “*heroes*”, having *limitless agency*, overly voluntarist and completely dis-embedded from institutions, which they strive to change. On the other hand, is the highly deterministic view of institutional theory, which considers individuals (persons or organizations) as embedded in institutions, i.e., their norms and beliefs are determined by the institutions. Thus this embeddedness should not enable them to change the institutions.

In order to reconcile this paradox within the tenets of institutional theory, *Battilana et al. (2009)* have proposed that the concept of institutional entrepreneurship should be studied between the two limits: on the one side is the rational choice of agency and on the other side is the structural determinism. Within these two limits, actors (individual or organizational) exercise their agency. Following this line of argument, different researchers have identified the conditions which constrain or enable the actors to introduce a divergent change. Broadly, enablers are of two types, namely personal characteristics of the actors and the characteristics of the context or field level conditions(*Bernard Leca et al., 2008*).

Kitchener and Leca (2010) have, however, argued that this notion of agency actually conflates agency and structure. *Hodgson (2007)* has pointed out that different scholars have conflated agency and structures differently. Their approaches are termed as methodological individualism(upward conflation), methodological collectivism (downward conflation), and center conflation. Although the proponents of methodological individualism are far from any consensus in their views, the broad concept is defined as “social structures, institutions and other collective phenomena should be explained in terms of the individuals involved”. *Lachmann (1969, as cited in Hodgson 2007)* argued to explain all social phenomena in terms of human plans. *Elster (1982, as cited in Hodgson 2007)* has defined methodological individualism as a “the doctrine that all social phenomena (their structure and their change) are in principle explicable only in terms of individuals—their properties, goals, and beliefs”. *Hodgson (2007)* has contended that individual process information of the world in some frameworks which are developed through socialization. So, individual choices are not made in isolation and consequently it is not possible to explain social phenomena in terms of individuals only (p.98).

Similarly, methodological collectivism has also different expressions; one such expression is given in Marx’s statement: “the ruling ideas are nothing more than the ideal expressions of the dominant material relations” (*Hodgson, 2007, p.99*). In another statement, Marx said, “Men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given, and transmitted by the past” (*Scott, 2013, p.55*). *Hodgson (2007)* has pointed out that an explanation only in terms of social structures cannot be accepted because it has not taken into account the diverse nature of human beings and thus has not given any weightage to human agency. Other famous scholars who have resorted to methodological collectivism are Émile Durkheim, Max Weber, and Talcott Parsons(p.100).

Many other scholars, such as Anthony Giddens in his structuration theory(1984), have attempted to find middle path between methodological individualism and methodological collectivism. They have proposed ideas which can be described as center conflation. Craib (1992) in his commentary of Giddens has described structure and agency not as “*separate and opposing things in the world or as mutually exclusive ways of thinking about the world*”, instead “*simply two sides of the same coin*”. Many philosophers proposed that reality exists in layers, called layered ontology, these layers can be “*physical, molecular, organic, mental, human individual, and social levels*” and cannot be reduced to a single layer. However, Structuration theory propose only a single layer of reality where individuals and social structures are conflated into one layer. As a result, Hodgson has pointed out that “*Structuration theory is forced to accept a single level of reality, with noting (social or otherwise) above it, and nothing (natural or otherwise) below*” (Hodgson, 2007, p.103).

One promising alternative to the above-mentioned different forms of conflation is Critical Realism. Critical Realism proposes a stratified reality and thus provides a non-conflated view of agency and structures as both agency and structures are at different levels of reality. So, it is better suited to study institutional entrepreneurship (Kitchener & Leca, 2010; Bernard Leca & Naccache, 2006).

Archer (1995) has pointed out that non-conflationary theorists have conceptualized the problem of structure and agency entirely differently due to their “emergentist⁴ ontology”. Their conception is called as “analytical dualism” which is based on two premises: First, reality in social world is stratified and as a result structures and agents cannot be reduced to one another, i.e., “they are analytically separable”. Second, structures and agents are temporally distinguishable. So, “it is justifiable and feasible to talk of pre-existence and posteriority when dealing with specific instances of the two”. This concept “can be used methodologically in order to examine the interplay between them and thus explain changes in both - over time” (p.66). Thus for studying the interplay between structure and agency will require the *linking* of the two and avoid *sinking* one into the other.

Delbridge and Edwards (2013) have also noted that in order to study the interplay of structure and agency, analytical dualism is a pre-requisite. Conflation (whether upward, downward, or center) cannot help us to study this interplay. Delbridge and Edwards (2013) have developed a theoretical framework to study a non-conflated view of human agency and its relationship with the structures. This framework is discussed later in this chapter in the section 2.6.

Hodgson (2006) has reconciled the debate on structure and agency and has reported the contemporary view on institutions (structures) as “*simultaneously both objective structures ‘out there’, and subjective springs of human agency ‘in the human head’. Institutions[structures] are in this respect like Klein bottles: the subjective ‘inside’ is simultaneously the objective ‘outside’. The institution thus offers a link between the ideal and the real*”(p.8). Institutions provide enablements as well constraints, however, Hodgson (2006, p.7) has indicated that institutions as social structures act “*to some degree upon the habits of thought and action*” of the individuals. But that “*does not mean that institutions directly, entirely, or uniformly determine individual aspirations*”.

⁴ Emergent property of a social unit means units which exist at upper levels “are not mere epiphenomena of lower-level units” (Hodgson, 2007,p.103). A similar term, called “creative synthesis”, used by Lester F. Ward, suggests that “there is absolutely no form which in the meaning and value of its content is not something more than the mere sum of its factors or than the mere mechanical resultant of its component”(Ward, 1916, p.79).

2.3 The enabling conditions for institutional entrepreneurship

The necessary conditions which help actors to become institutional entrepreneurs or help the institutional entrepreneurs to implement a project of institutional change are called enabling conditions. Three categories of enabling conditions are identified in the literature. First is the enabling role of field-level conditions which are further categorized in three categories. First is the external jolts. Initially, institutional theorists focused on external jolts as the enabling conditions of change. These exogenous conditions included “*social upheaval, technological disruption, competitive discontinuities, or regulatory changes*” and “*economic or political crises*”. In fact, these external jolts shake the field level consensus, consequently, give an opportunity to institutional entrepreneurs to bring change in the institution. Second type of field-level enabling conditions include presence of a severe problem which converts into a crises, or shortage of resources that can force actors to migrate into another field and act as institutional entrepreneurs in other fields (Greenwood & Suddaby, 2006). The third type of field-level enabling conditions are related to field characteristics. These include “*field’s degree of heterogeneity and institutionalization*”, “*presence of multiple institutional orders or alternatives*”, “*the less mandatory and more optional an institution, the easier to deinstitutionalize*”, and presence of “*institutional contradiction*”. All these conditions provide actors an opportunity to exercise agency. Second type of enabling conditions are the role of actors’ social positions. Third type of enabling conditions is the role of actors’ specific characteristics (Greenwood & Suddaby, 2006; Bernard Leca et al., 2008; Mutch, 2007).

2.4 The process of institutional entrepreneurship

Bernard Leca et al. (2008) have also noted that ‘institutional entrepreneurship is a complex political and cultural process’, because institutional entrepreneurs have to ‘mobilize allies’ especially ‘key constituents such as highly embedded agents’, ‘develop alliances and cooperation’, utilize variety of social skills, and mobilize different resources. In order to implement the institutional change, institutional entrepreneurs have to win the support of different groups who are the beneficiaries of the status quo; sometime this support is won and other times the change is imposed on them. The most important aspect in the process of institutional entrepreneurship is the development of a discourse and texts to change the institutions. Researchers have called it development of discursive strategy. In this process, institutional entrepreneurs “frame grievances and interests of aggrieved constituencies, diagnose causes, assign blames, provide solutions, and enable collective attribution processes to operate”. It means institutional change agenda must be based on the problems, values and interests of the potential allies to garner their support. After developing a discursive strategy, mobilization of resources is the next step.

Institutional entrepreneurs mobilize different kind of resources, tangible and intangible. Amongst the tangible resources, financial resources are the most important, especially at the initial stages of the change project, to overcome the opposition of the privileged actors of the field who opposed the proposed change. Financial resources are also needed to pressurize some of the opponents to seek their support. In the intangible resources, “*social capital*”, “*legitimacy*” and “*formal authority*” are identified in the literature. *Social capital* is the position of a person in different kinds of social relations which provides him information and political support and the person’s ability to use these two resources to influence others. *Legitimacy* is the perception about entrepreneur’s previous actions whether or not they were aligned with the “*values and expectations of the larger environment*”.

Suchman (1994, as cited in Scott 2013) has defined legitimacy as “a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions”. Scott (2013) has further noted that legitimacy is not a resource or commodity which can be exchanged, rather it is a precondition for social action and can only be realized when it is lost. (p.71-72)

In an emerging field, institutional entrepreneurs need to seek legitimacy amongst diverse groups and not in a narrow group. However, in mature fields support from the dominant members can suffice to make the institutional project a success. In social groups, entrepreneurs try to connect the values of their cause with their personal identities. For example, Maguire, Hardy and Lawrence (2004) have noted in study that in 1980s social activists who were gay and HIV positive had more legitimacy amongst the social movement which was trying to develop treatments for HIV patients in coordination with the pharmaceutical companies. Formal authority is “actor’s legitimately recognized right to make decisions”, such as authority of a state is an example of formal authority. Such authority helps institutional entrepreneurs to develop and sell their discourses for change. The role and importance of the intangible resources depends upon the context of the field (Bernard Leca et al., 2008).

Review of this literature shows that over the years, scholars have moved from the view of institutional entrepreneurs as disembodied heroes to embedded actors, whose context is important as it not only provides enabling conditions but also constraints to their actions. As the purpose of this research is to explain the role of academics in institutionalizing the field of regenerative medicine, an interdisciplinary and applied field, in University of Tampere, it is pertinent to review the relevant literature on academic entrepreneurship.

2.5 Academic Entrepreneurship

The role of academics in transferring knowledge to industry has been studied by many scholars. Miller et al. (2017) have systematically reviewed articles on academic entrepreneurship published between 1990 and 2015. While noting the nuanced differences and synthesizing the various views, they have differentiated between entrepreneurial academics and academic entrepreneurs and have proposed comprehensive definitions of the two. Entrepreneurial academic is an ‘academic faculty member who adopts an entrepreneurial outlook and who supports his/her research objectives by engaging with commercial partners in a range of collaborative and less formal modes of engagement’. On the other hand, academic entrepreneurs are ‘academic faculty member who undertakes technology commercialization, using formal modes of engagement, which capitalize on specific market opportunities’. They have further identified different modes of engagement of these academics for knowledge transfer. For instance, entrepreneurial academics engage in less formal modes of engagement, which include ‘networking’, ‘joint conference’, ‘joint journal publications’, joint supervision of research projects of students, placement/employment of graduate students in the partner companies, secondment of staff to the other organization for a period of time, offering education to executives, and collaborative research to solve a problem or explore new knowledge. On the other hand, academic entrepreneurs engage in more formal modes of engagement, which include ‘contract research and consultancy’, development of facility shared by university and commercial partners, joint ventures that bind the academics with their commercial partners without creating a legal company, licensing or patenting a specific piece of knowledge either by academics or their commercial partners, and creating formal companies, called spin-outs, jointly by academics

and their commercial partners. They have also summarized the motivational basis of the two types of academics and the challenges they face.

2.5.1 Motivations

Miller et al. (2017) have noted that academics take part in different modes of knowledge transfer due to various motivational basis. These motivational basis differ to some extent among entrepreneurial academics and academic entrepreneurs. For instance, entrepreneurial academics partake in knowledge transfer activities mainly for furthering their research objectives, getting feedback about the validity/appropriateness of their research question and chosen approach, gaining peer recognition and academic esteem, contributing to their academic field, contribution to big societal challenges, and earning income for their institutions. Contrary to them, academic entrepreneurs embark upon the projects of knowledge transfer mainly for understanding the commercial lifecycle/adoption of their research outputs, recognition by the public, and realizing the additional sources of personal income.

With these theoretical understandings, it is now time to identify some theoretical frameworks which can be helpful in explaining institutional entrepreneurship in the institutionalization of regenerative medicine research field.

2.6 Conceptual Frameworks

In this section initially three independent theoretical frameworks are discussed. These frameworks are complimentary to some extent. First framework is developed by Cai (2017) to study innovations in higher education. Second framework is developed by Battilana et al. (2009) to study institutional entrepreneurship and the third framework is developed by Delbridge and Edwards (2013) to study institutional change using critical realism and some personal characteristics of the actors. After the brief introduction of each framework, important components of the each framework are combined for the data analysis of this thesis.

Cai (2017) has developed a framework to study the concept of innovation in higher education. The proposed framework is composed of an earlier framework developed by Benneworth, Coenen, Moodysson and Asheim (2009) and some other elements identified by many scholars to study innovation in general or in higher education in particular. The framework of Benneworth et al. (2009) had six elements namely aim, type, nature, means, social context, and stages of innovation (Cai, 2017). While acknowledging its strengths, Cai has complemented this framework with a few more elements identified by other scholars of innovation studies to develop a comprehensive framework for studying innovation in higher education. Further elements are problem to be solved by innovation, human actors, the learning curve, and factors affecting institutionalization process of innovation. Cai's final framework is given in Figure 2.1.

Two elements of this framework are very important for the purpose of this thesis: the context and the people. Context including the social structures, institutions, and organization culture, and broader socio-economic environment in which universities or academics operate are important for understanding innovation process, because both enable or constrain the innovation process. It is especially important in the background when the society and economy now expects more active role from universities in the development of economy and society. So, the new the socio-economic context is affecting innovation process in higher education and vice versa. As a result, it is important

to capitalize on general innovation studies, for instance, National Innovation System and Triple Helix System studies. These concepts can help researchers to understand the context in which universities now operate. In addition, studying the organizational culture is essential to understand innovation process because a supportive culture is also essential for innovation (Cai, 2017, p.600-01).

The next element is human actors; amongst them, three types are very important in innovation in higher education including university leaders, managers, and academics. Reform, innovation or change, especially introduced in the management and governance often introduced by the university leaders and managers, is mostly resisted by the academics who decouple themselves from the change to safeguard their identity. Therefore it is important to understand how academics respond to the change, or how they exercise their agency when confronted with the changes which challenge their identities or professional commitments. In addition, other stakeholders are also important in the implementation of innovation and change. Thus, identifying the people who can play important role in innovation process is important starting point for understanding analysis of innovation process (Cai, 2017, p.605).

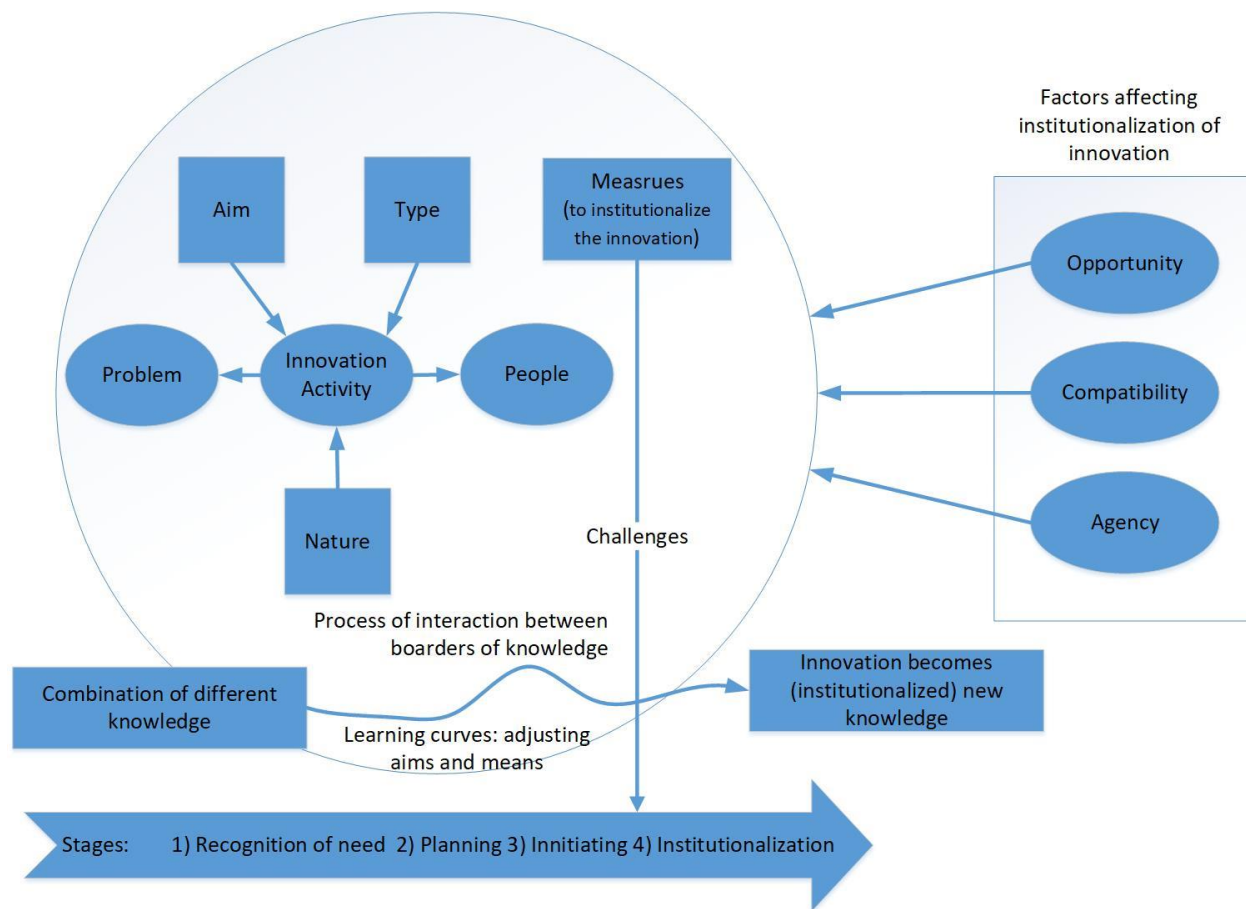


Figure 2.1: Analytical framework for understanding innovation process (Cai, 2017)

In the factors affecting the institutionalization of innovation, Cai (2017) has identified three elements, namely profitability, compatibility and agency. While the first two of these are important factors, agency, on the other hand, should be considered as part of the human actors, discussed

earlier. Because human actors can exercise agency to change an institution (Battilana et al., 2009) or they can exercise agency by ‘resisting’, ‘critiquing’, ‘negotiating’, ‘operationalizing’, and ‘acquiescing’ when the innovation or change affect their identity or commitments (Gonzales, 2012, 2014, 2015). However, this framework does not fully explain the relationship and the interplay between the context and the human actors at micro level, i.e., how actors’ motivation, identities, emotions, passion, social position, and characteristics change the context or vice versa.

Second framework is developed by Battilana et al. (2009). They have tried to reconcile the “*paradox of embedded agency*” , mentioned earlier in this literature review, by proposing that the concept of institutional entrepreneurship should be studied between the two limits: on the one side is the rational choice of agency and on the other side is the structural determinism. Within these two limits actors (individual or organizational) exercise their agency. Following this line of argument, different researchers have identified the conditions which constrain or enable the actors to introduce a divergent change. Amongst the enablers are personal characteristics of the actors, their social positions, and the context or the field level conditions (Battilana et al., 2009). These enabling conditions motivate actors to strive for change which they achieve by creating and promoting a vision for change, mobilization of resources, and mobilization of allies behind their vision. The framework is illustrated in Figure 2.2.

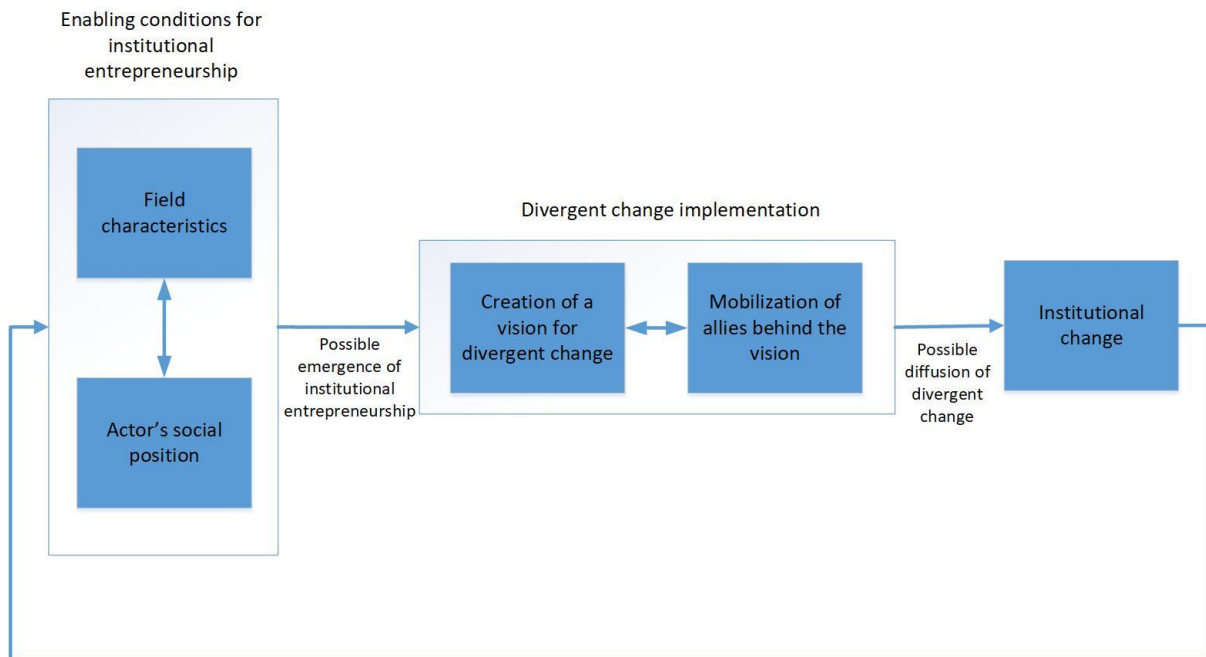


Figure 2.2: The process of institutional entrepreneurship (Battilana et al, 2009)

Like Cai (2017), this framework gives great emphasis to the context of innovation, however, this framework is based on very limited concept of human motivation, i.e., rational choice motivation. Human being, or academics specifically, on the other hand can have motivations beyond rational choice. Archer (2000) has critiqued the so called rational choice model of human motivation. She has argued that scholarly discourses have systematically taken passion out of human preferences “*such that the remaining preferences could be drawn into the ambit of rational choice*” (p.37).

Consequently, she has proposed that people's commitment, emotion, and passion are important sources of human agency. Thus the conceptualization of human agency is very limited in this framework.

Furthermore, as have been discussed earlier in this literature that most of the social scientists construe reality in layers. So, for a robust framework, it is essential to explain the hierarchical levels between various elements: especially actors and structures for this research to avoid all sorts of conflation (upward, downward, or center conflation). However, both of the above frameworks have not delineated this layered relationship between the two realities, human actors and structures.

Delbridge and Edwards (2013) have developed a framework which draws upon ontology of '*critical realism*', proposed by Bhaskar (1975) and Archer (1995), '*agentic orientation*', proposed by Emirbayer and Mische (1998), and actors' '*internal conversation*', proposed by Archer (2003), to study the likely outcome in the form of institutional maintenance or change. This framework explains the multi-level interdependence amongst actions, contexts, and institutional logics [Structures], because it treats agency (or action) and structures as analytically two distinct concepts (or phenomenon). By distinguishing between actions and structures, it is possible to study how social structures condition action. Delbridge and Edwards (2013) have indicated that actions are not determined, but conditioned by numerous factors including institutional logic (macro level), institutional setting (meso-level), and other micro level factors such as agentic orientations, internal conversation, and past experiences of actors. In return, institutional logic and institutional settings are also affected or changed by the actors' actions. Most importantly, this framework avoids all form of conflation between agency and structure including upward, downward, or center conflation. Thus, it helps to understand the interplay between the human agency and structures. This framework pays attention to the reflexive capacities of the agent and recognize the need to study the historical experiences or even biographies of the actors to know if the actors see the circumstances as constraining or enabling. In addition, agents' internal conversations, also called as modes of reflexivity, and their orientation (whether agent wants to change the world or maintain it when they engage with it) towards institutions are also considered important. These concepts help in explaining the degree to which actors can evaluate their relations with their social world. Each element of this framework is explained in the next paragraphs starting from the concept of human agency.

Emirbayer and Mische (1998) have defined agency as a 'chordal triad' which is "*temporally constructed engagement by actors of different structural environments—the temporal relational contexts of action—which, through the interplay of habit, imagination, and judgment, both reproduces and transforms those structures in interactive response to the problems posed by changing historical situations*" (p.970). This definition identifies three analytically distinct dimensions of human agency, including iteration, projectivity, and practical evaluation which are also called as the three agentic orientations. In other words agency is a "*a temporally embedded process of social engagement, informed by the past (in its habitual aspect), but also oriented toward the future (as a capacity to imagine alternative possibilities) and toward the present (as a capacity to contextualize past habits and future projects within the contingencies of the moment)*" (Emirbayer & Mische, 1998, p.963).

Iterational orientation gives "*stability and order to social universes ... helping to sustain identities, interactions and institutions over time*". It is related to the past. *Practical-evaluative* orientation is "*the capacity of actors to make practical and normative judgments among alternative trajectories of*

action, in response to the emerging demands, dilemmas, and ambiguities of presently evolving situations". It is related to the present. Finally, *projective* orientations are "*imaginative generation by actors of possible future trajectories of action, in which received structures of thought and action may be creatively reconfigured in relation to actors' hopes, fears and desires for the future*". It is related to the future (Emirbayer & Mische, 1998, p.971). They have further indicated that "human actors do not merely repeat past routines; they are also the inventors of new possibilities for thought and action"(p.983). They have indicated that projectivity is observed many empirical studies including studies on innovation. Therefore, understanding *projective imaginations* of human actors are important for understanding institutional innovation (p.993).

Citing Archer (2000), Gonzales (2015) has argued that understanding human agency is actually understanding people's emotion, passion, and commitments. She has further indicated that "*agency is underlined by a process where we reflexively take stock of who we are and who we want to be as we seek to act in the world. It is not a rational process if one uses the typical definition of rationality (resource/time maximization, efficiency, productivity), but it is a process guided by an emotional commitment or even a political sense of self ... This is an important point of departure for studies of agency, broadly, and for studies of faculty agency, more specifically. Many studies on faculty work life assume that faculty members simply respond to evaluation policies and practices ..., but ...faculty ... reconcile structure and cultures ... with the deep commitments that they [hold]*". (p.319)

Archer (2003) have discussed four modes of *human reflexivities*, also called *internal conversations*. Based on it, four types of human reflexives are "*communicative reflexives*", "*autonomous reflexives*", "*meta reflexives*", and "*fractured reflexives*". *Communicative reflexives* "complete their internal conversation inter-subjectively or in the context of others". These reflexives undertake their personal goals in the reference of others, so the scope of change is limited, because their personal goals depicts 'contextual continuity'. *Autonomous reflexives* "conduct their internal conversation 'at distance' from existing arrangements, which can lead to contestation with incumbents". As they undertake their personal project in 'contextual discontinuity', therefore scope of change is quite broad. Therefore, the chances of this type of reflexives are higher to become institutional entrepreneurs. *Meta reflexives* "not only monitor personal projects but also review the reflective process itself". Their reflexivity may or may not bring a change in the existing institutional context. Finally, *fractured reflexives* are "the victims of society who are unable, for whatever reason, to engage in an internal conversation. These actors are the closest to being 'social dopes'; it is because of their involuntary positioning in society that they are unable to change their situation" (Archer, 2003; Delbridge & Edwards, 2013). Archer (2003) has indicated that the causal power of social forms/structures is mediated through mediatory process of agency. For structural and cultural factors to exercise their powers of constraints and enablements is dependent upon three things. First, the existence of human projects; if there is no project, no enablement or constraints will exist. Second, there must be a relationship of congruence or incongruence between agentic projects, enablements and constraints. Third, These enablements and constraints can condition but not determine agentic acts. Their conditioning is contingent upon reflexive deliberation of the agents. Thus, agentic reflexivity, which has emergent properties (already explained in footnote 4), can have its own causal power.

By combining the orientations of human agent with the modes of their internal conversation, the potential outcome can be depicted in terms of transformation, reproduction, taken-for-granted

continuity, and change in a complex institutional context (Delbridge & Edwards, 2013). This is shown in the Table 2.1 (below).

Table 2.1: Agentic forms of reflexivity (Internal Conversations)

Agentic Orientation	Action orientation: Internal Conversation	Potential outcomes: transformation/reproduction
Past	Iterational: communicative/fractured reflexive	Taken-for-granted continuity
Present	Prctical-evaluative: meta/autonomous reflexive	Negotiated continuity and/ or change
Future	Projective: autonomous reflexive	Change

Source: Inhabiting institutions: Critical Realist Refinements to understanding institutional complexity and change (Delbridge & Edwards (2013)).

2.7 A Synthesized framework

In the previous section, three theoretical frameworks have been explained. It was further noted that each framework had strengths as well as some deficiencies. Therefore, it is essential to take the important elements of each framework while complementing them with the elements of the other frameworks to synthesize a framework which can explain the role of individual actors in institutional change. The most important elements of the proposed framework are constraints and enablements in which actors have to perform. In the previous section, it was indicated that various scholars have emphasized the constraining and enabling characteristics of institutions (Dimaggio & Powell, 1983; Hodgson, 2006, 2007). Using ontology of critical realism, these constraints and enablements can be identified separately, because institutions are “subjective inside” as well as “objective outside”. Therefore, in a study of institutional change, it is essential to identify the institutional constraints as well as enablements. Battilana et al. (2009) have identified three categories of institutional enablements which have already been discussed in the section 2.3. However, there is need to expand the category of ‘actors’ specific characteristics’ in their model by including those elements which have been identified by Delbridge and Edwards (2013), namely *projective orientation*, *internal conversation*, and past histories of the actors and including the Archer’s sources agency, namely emotions, passions, and commitments. The resulting framework is show in Figure 2.3.

In order to use this framework, it is essential to know how to operationalize some of the elements of this framework, for instance, *actors’ projective imaginations* and *internal conversation*. Mische (2009) has argued that projected future is a dynamic force behind social change. She has identified nine dimensions of projective imaginations, including “*reach, breadth, clarity, contingency, expandability, volition, sociality, connectivity, and genre*”. Expandability is an important dimension of future imaginations which is important for this study. It is the “*the degree to which future*

possibilities are seen as expanding or contracting”. People who have expanding temporal horizon(for instance, in young age) they perceive many possibilities. As a result, they start new career, explore new areas, or start new romance etc. While the people who perceive future possibilities as declining(for instance, in terminal illness or in old age), they “*may rescale their goals toward more a feasible range*”. So, hope and confidence are the indicators of expanding future possibilities. While fear and desperation are indicators of shrinking future possibilities.

Based on Mische (2009) conceptualization of projected future, Frye (2012), in a qualitative study conducted on Malawian school girls, has pointed out that the imagined future or the high aspirations of underprivileged rural girls helped them to attain their educational goals by overcoming the institutional constraints. In the existing institutional constraints and opportunities, their educational aspirations seemed irrational. However, they could achieve their aspirations by making four important choices in the present, including “*ambitious career goals*”, “*sustained effort*”, “*unflagging optimism*”, and “*resistance to temptation*”. She has argued that studying statements about future aspirations and expectations are important because in these statements people express their moral claims and identities and not just rational choices.

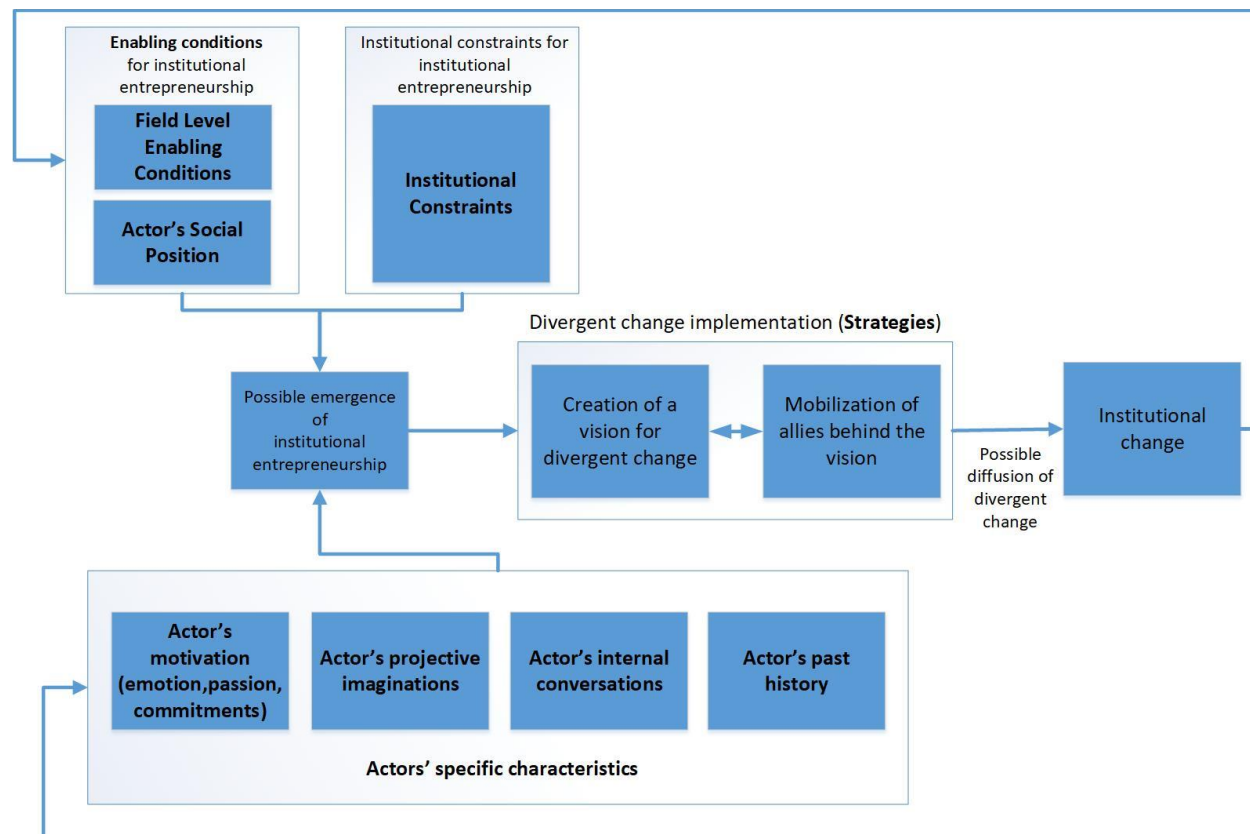


Figure 2.3: Synthesized Framework

Emirbayer and Mische (1998) have further argued that internal conversation is a process which gives analytical autonomy to human agency vis-e-vis transpersonal interactions. These transpersonal interactions do constrain and enable human actions, however, such interactions “cannot themselves serve as point of origin of agentic possibilities” (p.974). Critiquing on rational choice model, Archer

(2000) has given great emphasis to emotional commitments of the person. *“This person is conceived of as a strong evaluator of moral projects. The focus is, then, on ends, not means, as the prime concerns of persons, who engage in and reflexively monitor personal projects”*. In an empirical study, Archer (2003) has concluded that through internal conversation people evaluate their personal projects to which they are emotionally attached. Emirbayer and Mische (1998) have pointed out that *“such conversations are central to the exercise of agency”*. Archer (2003) has identified four types of internal conversations, including *“autonomous reflexivity”*, *“communicative reflexivity”*, *“meta-reflexivity”*, and finally *“fractured-reflexivity”*. For studying innovation and institutional change, autonomous reflexivity is important. In this type of reflexivity *“actors conduct their internal conversation ‘at distance’ from existing arrangements, which can lead to contestation with incumbents as these actors seek to pursue their own projects despite the social structures that surround them”*. Autonomous reflexives have three important characteristics: contextual discontinuity, unproblematic dovetailing of their concerns, individualism, and confidence. Based on her study, Archer (p.212) has defined ‘contextual discontinuity’ as *“to move away from their initial context of involuntary placement”*. Most of the subjects in Archer’s study had a discontinuous contextual background. Their movement included geographical moves, for instance attending a boarding school. These geographical moves shed their network of family and friends and rarefied their *“contextual resource”*. While the unproblematic dovetailing with their concern means that work was their top priority and their *“interpersonal relationship have to be subordinated by this ultimate concern”*(p.213).

By using this framework, it can become easy to explain why actor placed in the same contexts, seek divergent path. Some seek change while others accept the existing arrangements. This framework include one the one hand the “rational motives” of the actors which are based on the cost-benefits analysis keeping the institutional constraints and enablements in view. But on the other hand, it also incorporate the other motives of the actors which may not be based on cost-benefit analysis. Thus this framework acknowledges that institutions “condition”, but don’t “directly, entirely, or uniformly determine individual aspirations”. So, this framework incorporates the *“boundedly intentional model of human behavior”*.

3 Research Methodology

In this chapter first the chosen methodology for this research has been explained in section 3.1. It is further identified and explained the important step involved in a case study, the chosen methodology for this study. From section 3.2 to section 3.7 important steps of case study are explained with the relevant choices and actions taken in each step to conduct this study. In section 3.7.1, participants profile is given and the issue of disclosure of participants' identity is discussed. In section 3.8, the validity and reliability of this case study are discussed.

3.1 Case Study

For this thesis, case study is chosen as methodology. Creswell (2012) has noted that different scholars have accepted case study *“as a strategy of inquiry, a methodology, or a comprehensive research strategy...[he] view it as a methodology: a type of design in qualitative research that may be an object of study, as well as product of the inquiry”*. Case study is a qualitative technique in which the researcher *“explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time”*. Yin (2013) has argued that case study helps to understand a complex social phenomenon. It helps to *“retain a holistic and real-world perspective”* in studying *“individual life cycle, small group behavior, organizational and managerial processes, neighborhood change, ...and maturation of industries”*. As the purpose of this thesis is to study a divergent change in University of Tampere, case study is an ideal research methodology for this research.

Yin (2013) has proposed following twofold definition of a case study:

1. *“A case study is an empirical inquiry that investigates a contemporary phenomenon (the ‘case’) in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident”*.

In real-world situations, the context and phenomenon are not always be clearly differentiated, therefore, other methodological characteristics become relevant as the feature of the case study:

2. *“A case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result... [it] relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result... [it] benefits from the prior development of theoretical propositions to guide data collection and analysis”* (p.16-17)

He has described case study research as a *“linear but iterative process”* which can be illustrated by Figure 3.1. Each step shown in Figure 3.1 is explained next.

3.2 Plan

Yin (2013) has argued that case study can be used not only in the descriptive and exploratory phases of investigation, but it can also be used for explanatory phases. As an example, he has cited the case study of Cuban Missile Crises during Cold War, conducted by Allison and Zelikow (1999), which was an explanatory investigation. Yin (2012) has also cited another example of university

innovation, “*The effect of a Federal Award on University Computer Science Department*” in which researchers have used case study strategy for explanatory purpose (Chapter 7). On the basis of these examples, Yin (2013) has further noted that even a single case study can be “*a basis for significant generalizations*”(p.7). It is possible, because case study “*expands and generalize theories(analytical generalization) and not to extrapolate probabilities(statistical generalizations)*”(p.21). As the purpose of this study is to explain how actors exercise their agency or mediate structures, therefore, it is an explanatory case study. Using the classification developed by Stake (1995) based on the *intent* of a case study, it is an *instrumental case study* because intent of this study is to investigate the role of human agency in the institutionalization process of a new field medical research.

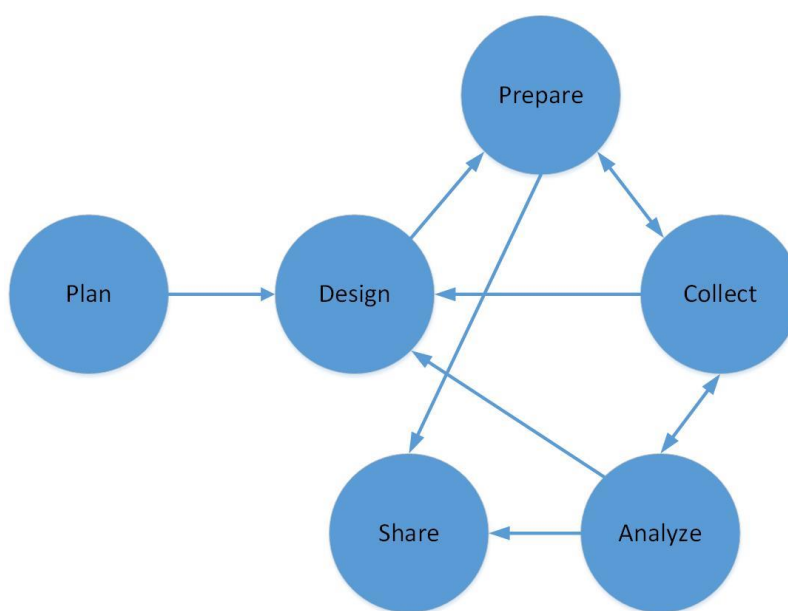


Figure 3.1: Case Study Research: A linear but iterative process (Yin, 2014)

Case study research embraces different epistemological perspectives, such as *relativism*, *interpretivism*, and *realism* (Yin, 2013, p.17). While *relativists* perspective assumes multiple social realities which are observer dependent, *realist* perspective assumes that a single reality exist out there independent of the observer. In this case study, a critical realist perspective about social reality has been adopted. Bernard Leca and Naccache (2006) have noted that during data collection phase critical realist researcher considers both the empirical and actual domain.

Archer (1995) has proposed to use analytical dualism as methodology to study the interplay of structures and actions. Gonzales (2015, p.307) has indicated that using analytical dualism as methodology requires that the researchers should fully record the details or conditions of the structures and should try to understand the relations between actions and those conditions. She has further proposed that the researchers should start from “*the assumption that structures ‘are there and that the problem is how to get rid of them or deal with them’*”. Using “*analytical dualism means one seeks to study how and when agency is taken in relation to structural and cultural conditions*” (p.307).

3.3 Design

Yin (2013) has described research design as “*logical sequence that connects the empirical data to a study’s initial research questions and , ultimately, to its conclusions*”(p.28). He has further noted that five elements are essential in the design of a case study. These elements are “*case study questions*”, “*its propositions (if any)*”, the “*unit(s) of analysis*”, the “*logical linking of the data to the propositions*”, and finally, “*the criteria for interpreting the findings*”. Research question of this study is given in *chapter one* and propositions, given in chapter two, are in the form of theoretical concepts taken from the frameworks developed by Cai (2017), Battilana et al. (2009), and Delbridge and Edwards (2013). The unit of analysis is the new field of regenerative medicine research in UTA. But within this unit of analysis (or case) there are many embedded cases of individual actors. In the embedded cases, the unit of analysis is individual actions (actions of individual academic leaders who played a key role). This categorization is aligned with Delbridge and Edwards (2013) theoretical framework where they have mentioned two units of analysis: micro-level actions and meso level. Unit of analysis is decided on the basis of findings of this study, which, on the one hand, adds to the literature on institutionalization of a divergent change in a field and, on the other hand, contribute to the understanding of human agency and its relationship with the structure. In terms of time, this case study has covered the time period from 1986 to 2017 and in terms of place, it is located in Tampere (Finland) (bounding the case).

3.4 Prepare

A data collection protocol was prepared in March 2017. Based on the qualitative data, a quantitative questionnaire was also developed for collecting more responses and to validate the qualitative findings. The respondents were asked to reply various statements on a Likert scale. The questions are given with the graphs displayed in this thesis.

3.5 Collect

In order to collect data, various data collection techniques were used such as, interviews, documents, annual reports, published researches, and websites. Many academics played important role in developing and institutionalizing the regenerative medicine research field in Tampere, but only those were interviewed who wished to participate in this study. Participants were selected using snow-ball sampling techniques. Two researchers were first selected and were requested for interviews through email invitations. In the second week of April, both the researchers were interviewed. They identified the key actors who were then requested for interviews through emails. Some of the prospective interviewees were very prompt in responding to emails, however, some accepted the request once they were contacted by visiting their offices. During April, May and June total twelve interviews were conducted. Last interview was conducted on June 20, 2017. Average length of an interview was 60 minutes. However, with one interview two interviews were conducted, each interview was of 60-70 minutes long.

3.6 Analyze

All the interviews were transcribed and were analyzed using trial version of NVivo 11, a qualitative data analysis software by QSR International. As this case study was about an innovation in higher education institute, therefore it was important to study the role of human agency as Cai (2017) as identified it as an important element in his theoretical framework for studying innovation. Further

concepts were taken from two other theoretical frameworks mentioned in section 3.3. Important theoretical elements are *internal conversations of actors, especially their autonomous reflexivity*, the concept developed by Archer (2003) and *projective agentic orientation* developed by Emirbayer and Mische (1998). In addition, this framework utilizes Archer (2000) concept of human agency as emotions, passions, and commitments. To get a rival explanations of the case study, a second framework developed by Battilana et al. (2009) was also used. This framework is based on the rational choice explanation of human behaviors and emphasize to study institutional *constraints and enablement*, and Actors' positions as important elements. So, in this case human agency can be clearly identified by controlling the role of entablements and actors' position.

3.7 Share

This case is written in chronological order. A timeline of various events is given in **Error! Reference source not found.** Yin (1989, p.189) has noted that for explanatory case studies, chronological structure is a good option because it let the reader to evaluate a causal relationship, if the case writer has presumed one.

3.7.1 Participants' Profile and Identity Disclosure

Twelve people who were interviewed for this thesis have been involved in teaching, research, and management. Some of the very important actors could not be reached for this study. For instance, an important actor in the second phase(2003-2011) was Professor Riitta Seppänen-Kaijansinkko who was head of Regea Institute of Regenerative Medicine. She could not be reached for the interview, but some important information was collected about her and the role she played. In addition to the key actors, some academics were interviewed to validate the roles played by the other academics. Similarly, some academics turned down the request for interview due to their personal reasons.

One important issue was to choose the option between keeping the participants of the case anonymous or disclosing their identities. Yin (1989, p.196-7) has noted multiple benefits of disclosing the identities of the participants of a case:

- The readers can easily connect the case with previous information, if they acquired any through their reading or own research related to the same case.
- With their own information about the case and through the new information they get now, the reader can come up with their own analysis.
- It is also easy for the researcher to compose the case, share with participants to get their feedback(member checking).

On the basis of the benefits mentioned above, this researcher chose to disclose the identities. Before disclosing the identities of the person interviewed for this research and whose names are mentioned in this thesis, the manuscript was sent to them to get their permission for the disclosure. All of them generously allowed this researcher to use their original names in the thesis. Some of them suggested minor corrections also.

In this case, it is observed that multiple actors played significant role at different stages due to various reasons. In the first phase (1986-2003), amongst many actors who played important role, only two actors, namely Professor Timo Ylikomi and Professor Pertti Törmälä have been discussed. Other important actors of this phase were Minna Kellomäki, Professor Hanna Tähti, Timo Lahti, Kalevi

Lauslahti, and Matti Eskola. In the second phase(2003-2011), Professor Riitta Seppänen-Kaijansinkko was important actor. In the third phase (2010-2017), Hannu Hanhijärvi was an important actor who was the leader of BioMediTech. In the second and third phase there were many other actors who have been discussed briefly, but it was not possible to conduct interviews of all the actors due limitation of time.

3.8 Validity and Reliability of Case Study

3.8.1 Validity

Creswell (2012) has reviewed extensive perspectives of scholars on *validity* and *reliability* of qualitative research. Some of these scholars have defined these terms as qualitative equivalent of the terms in quantitative research, such as internal validity, external validity, reliability, and objectivity. Others have refrained from this tendency of using “the language of positivistic research”. Thus they have argued in favor of concepts which conforms to naturalistic research. While synthesizing these perspectives, Creswell (2012) considers validation in qualitative research as “an attempt to assess the ‘accuracy’ of the findings, as best described by the researcher and the participants. This view also suggests that any report of research is a representation by the author”. It can be achieved by spending extensive time in the field, developing a rich description of a case, and closing the gap between researcher and the participants. Validation can thus be termed as a process in qualitative research. There are various types of validity strategies . The authors should choose as many types of these strategies as they feel comfortable with. Creswell (2012, p.250) has proposed eight types of validation strategies which can be applied to case studies. These strategies include “*prolonged engagement with the participants*”, “*persistent observation*”, “*triangulation*”, “*peer review or debriefing*”, “*negative case analysis*”, “*clarifying researcher bias*”, “*member checking*”, “*rich and thick description of the setting*”, and “*external audits*”.

He has further recommended that the qualitative researcher must engage with at least two of the above strategies. He has also noted that due to various constraints which a researcher confronts, some of the above mentioned strategies may be very time consuming and thus may not be adopted practically. Gonzales (2015, p.310) has adopted three strategies to enhance the “*trustworthiness*” of her study on “*faculty agency in striving university context*”, including member checking, displaying extensive participant quotes, thickly described the setting, data taken from multiple sources to analyze the problem from different vantage point, and connecting “*the finding to the larger body of knowledge regarding striving, and faculty careers*”.

In the light of the above mentioned discussion, four strategies are used to enhance the accuracy or validity of the finding and analysis of this thesis, including *triangulation*, *peer review or debriefing*, *member checking*, and *rich and thick description of the setting including extensive quotations of the participants*.

- i. *Triangulation*: In order to corroborate the evidence, the researcher must use multiple sources of information, methods, and theories. For triangulation, the data was taken from multiple sources, including semi-structured interviews and qualitative data taken from published reports and articles (both scholarly and generalist) about the milestone and participants involved in the case study. Furthermore, a quantitative survey, which was developed on the basis of qualitative data collected in the initial phase of the study, was also conducted. The survey was developed online and the link was sent to senior researchers through email. The

researchers were given various reminders through email and telephone calls. Only seven researchers responded to the survey. Moreover, three theoretical framework are used in this study to analyze the data. First was rational choice model developed by Battilana et al. (2009), second was non-rational model developed by Delbridge and Edwards (2013), and the third was developed by Cai (2017).

- ii. *Peer review or de-briefing*: In this strategy, the researcher seeks help of a peer who asks tough questions about researcher's interpretations, methods, and meanings and thus provides an opportunity for reflection to the researcher. This peer can be called as a "devil's advocate" who keeps the researcher honest. So, it is an external mechanism for enhancing the accuracy or validity of the qualitative research. Both, peer and researcher, keep written accounts of their discussions, which are called debriefings. Regular thesis seminars in the University, meetings with the thesis supervisor and other scholars, and frequent discussion with some peers gave the researcher the opportunity to reflect on the analysis.
- iii. *Member checking*: In this strategy, the researcher gets views of the participants on the credibility of the findings and interpretations. In case study research, the participants must "play a major role directing as well as acting" (Stake, 1995, p.115). For member checking, the full or part of manuscript related to specific actors was sent to him/her for validity of facts and interpretation of the data. Their feedback was then incorporated in the final manuscript.
- iv. *Rich, thick description of the setting*: If the researcher describe the case with rich details about the context and participants, it helps the reader decide if the findings of the case can be applied or transferred to the other similar cases or not. A description is rich, if provides detailed information about themes, their interconnection, and quotes from the participants.

Sufficient details about the concept of regenerative medicine, various events, important milestones, and the actors (individuals and organizations) involved in promoting the idea of regenerative medicine research in Tampere are given. Moreover, the case description has extensive quotes of the interviewees, including their gestures during the interviews.

3.8.2 Reliability

Creswell (2012) has defined reliability in terms of *intercoder agreement*. He has defined reliability in qualitative research as "*stability of responses to multiple coders of data sets*". He has proposed that reliability of a qualitative study can be enhanced by taking all field notes, by employing good quality tape recording and then carefully transcribing them. Special attention must be paid in transcription to not only the content of the speech but also to the verbal pauses and overlaps. Furthermore, coding and analysis can be done by using computer software by the separate people who should have no knowledge about the expectations (p.253).

For this research, all the interviews were recoded using a good audio recorder and was then transcribed. It was further ensured to record the interviewees gestures, verbal pauses, and facial expression at various juncture during the interview. The data were analyzed using a trial version of NVivo 11, a qualitative data analysis software by QSR International. The gestures and the body language of the interviewees have also been indicated wherever their quotes are given in the description of the case, given in the next chapter.

4 Case Study Description

The field of regenerative medicine research requires extensive collaboration with practice, its establishment at the university that was mainly focused on basic research is a divergent change. The actors who played the key role in bringing the change can, therefore, be called as institutional entrepreneurs. In this case study, the various actors played the key role during different phases, from conceptualization to institutionalization of the new research field. In order to understand their role, it is important to understand the context.

In this chapter, first the introduction of the two important universities located in Tampere are given in section 4.1 and 4.2 respectively. In section 4.3, the history of research and commercialization of biomaterials in Tampere is discussed. Then the important events from emergence to the institutionalization of regenerative medicine research are described in a chronological order. These events include new discoveries, formation of new working groups of different stakeholders to capitalize on those discoveries, and establishment of new organizations working on regenerative medicine research. Furthermore, the mission, funding models, and evolution of these newly established organizations are also described here. However, aforesaid details are given under the title of the role of relevant actors of that phase. So, in section 4.4 the role of Professor Pertti Törmälä is discussed. In section 4.5, the role of Professor Timo Ylikomi is discussed. In section 4.6, the role of Riitta Seppänen-Kaijansinkko is described. In the section 4.7, the role of Hannu Hanhijärvi is described. In the section 4.8, the establishment of Center of Excellence on Body-on-Chip is discussed which marks a landmark achievement in the institutionalization of regenerative medicine research field in University of Tampere. This rich description of the case is important to ensure the validity of this case study and will also be helpful in analyzing the role of the actors and the associated institutional constraints and enablements in introducing and institutionalizing the new field of research.

4.1 Tampere University of Technology

Tampere University of Technology (TUT) was established in 1965 as a sub-campus of Helsinki University of Technology. In 1972, it got a status of an independent University. Since 2010, TUT is operating as a Foundation. Currently, TUT has five faculties Biomedical Sciences and Engineering, Computing and Electrical Engineering, Engineering Sciences, and Natural Sciences, and Business and Built Environment (Sinikka, 2017). In 2016, TUT had more than 10,000 students at undergraduate and postgraduate level including doctoral students and the total annual funding of the University was Euros 138.9 million. Out of this total funding, the University gets Euros 79.1 million from the Ministry of Education and Culture in the form of basic funding (Lehtola, 2017).

Faculty of Biomedical Sciences and Engineering is involved in multidisciplinary teaching and research in the fields of biomedical engineering and health technology. Further focus areas of research include bio-imaging, bio-materials, bio-measurement, bio-sensors and bio-robotics, personal health technologies, experimental and computational biosciences, and cell and tissue technology. The Faculty is actively involved in research collaboration with University of Tampere since 2003, initially through Regea Institute of Regenerative Medicine and then through Institute of Biomedical Technology, later named as BioMediTech(BMT). The collaboration has brought together experts from various disciplines of biosciences and biomedical engineering. At BMT, the Faculty's expertise in research is combined with expertise in medical science, biology, and

behavioral sciences, creating innovative solutions in the fields of health and well-being (Pirjo, 2017). Professor Pertti Törmälä is one of the important figure who initially played key role in developing innovative bio-absorbable products and later in promoting regenerative medicine research. He has been retired from TUT since 2005 (Häikiö, 2015, p.200-206). Other important researchers are Professor Minna Kellomäki, Professor Pasi Kallio, Professor Jari Hyttinen, and Professor Jukka Lekkala. Professor Minna Kellomäki is the current Dean of the Faculty. All of these professors of TUT were in their forties and were tenured before they joined their collaboration in regenerative medicine research filed in 2003-4. Academics at TUT have always been involved in collaborative research with industry. So, their focus has always been mainly on applied research.

4.2 University of Tampere

University of Tampere was established in 1925 in Helsinki as Civic College. In 1930 it was renamed as School of Social Science. It started working in Tampere in 1966. The University had nine schools which were merged into six different Faculties on January 01, 2017. The new Faculties are Faculty of Communication Sciences, Faculty of Education, Faculty of Management, Faculty of Medicine and Life Sciences, Faculty of Natural Sciences, and Faculty of Social Sciences.

The University has two campuses: the Main campus and the Kauppi campus located in Kauppi area of Tampere. In 2016, the University had approximately 15,000 students at undergraduate and postgraduate levels, approximately 12000 of these students were at undergraduate level. The total funding of the university was Euros 185 million. Out of this total, Euros 109 million was the basic funding coming from Ministry of Education and Culture. Academics of UTA have been mainly focused on research excellence.

4.2.1 Emergence of Regenerative Medicine Research at UTA

In the early 2000 some academics in Tampere started to take interest in regenerative medicine. Sotarauta and Mustikkamäki (2015) have reported that *“the term ‘regenerative medicine’ is used to describe “biomedical approaches to heal the body by the stimulation of endogenous cells to repair damaged tissues, or the transplantation of cells or engineered tissues to replace diseased or injured tissues. The basic unit in regenerative medicine is a stem cell. Stem cells are biological cells found in all multicellular organisms”*(p.346). As a result of the efforts of these academics a Steering Group was formed in 2003 comprising of actors from various organizations of Tampere including all the universities. In 2004, a formal organization called Regea Institute of Regenerative Medicine was established as the joint institute of UTA and TUT. In 2011, Regea was merged into bigger organization called BioMediTech which was also joint institute of UTA and TUT. Regenerative medicine research field gradually progressed in Tampere. In 2011, TEKES granted Euros 10 million for a project titled *“Human Spare Parts Project”* to the eight research groups, four from TUT and four from UTA, working on regenerative medicine. In 2017, six of these research groups received Center of Excellence award from Academy of Finland. The awarded is given for the year 2018-2025(AoF, 2017). The various landmark development in Tampere are shown chronologically in the timeline given in **Error! Reference source not found.**(below).



Figure 4.1: Timeline of Various Developments

4.3 The History of Biomaterials Research in Tampere

In 1986, for the first time in the world, two researchers from Tampere, Professor Pertti Törmälä of TUT and the Surgeon Pentti Rokkanen, developed a bio-absorbable screw to repair bone fractures. This screw was an alternative to steel screws which were used previously to fix bone fractures. Steel screws could cause infection in the body, while bio-absorbable screws could degrade after some time, once the bone fracture was healed. In order to commercialize their research, Törmälä and his fellows established two companies. It became point of departure for establishment of bio-absorbable material industry in Tampere in particular and Finland in general (Häikiö, 2015; Sotarauta & Mustikkamäki, 2015).

Emergence of biomaterials industry in Tampere was a precursor of regenerative medicine research field in 90s and 2000s. There are not only many similarities between the two cases, but some of the researchers, Professor Pertti Törmälä for instance, who were instrumental in developing biomaterials in Tampere played a pivotal role later in developing the field of regenerative medicine in Tampere.

Törmälä has been retired from TUT since 2005. He joined TUT in 1975 as an Assistant Professor in Material Science. According to Törmälä, Professor Pentti Kettunen, an institute leader, was a very important person in the middle of 70s in Finnish university life because he was strongly supporting and promoting cooperation between universities and industries. So, Professor Kettunen was in fact pioneer of Industry-academia Linkage in Finland. He is also retired now. Törmälä worked with him for almost one decade in the 70s. It was the beginning of Material Science in TUT. The Institute of Material Science was not only ahead of all other institutes in TUT but also of its contemporaries in

the whole Finland in working in close collaboration with the industry. It had very strong industrial partners. In terms of earning from industry, it was ahead of any other university institution in Finland at that time. Even the Helsinki University of Technology (HUT) started its collaboration with industry in the 80s. Due to strong support from government, HUT could then start collaboration with BAYER, one of the biggest industrial giant, but till late 70s, Institute of Material Science of TUT was number one in Finland, claimed Törmälä. But to reach at that level they had to overcome many challenges.

The biggest challenge for Törmälä and his colleagues was to make the big companies believe in their achievements. The big companies were not ready to believe in their achievements because these companies had already attempted to make bio-absorbable implants but had failed. So, it took many years before the big companies could accept that Törmälä and his colleagues had really made something new.

In early 80s, when Törmälä and his colleagues got good results in their research, they were convinced that the new knowledge could also be applied in making implants. In late 80s they had already developed different types of scaffolds, such as bio-absorbable scaffold, which was later used for creating a new tissue for dental surgery between teeth and bone. They also started to develop bio-regenerative scaffolds for small joints. After these achievements, Törmälä discussed his ideas with many Finnish companies, but there was no implant company in Finland at that time. So, he then discussed his ideas with several European and big companies of US. But the response was very discouraging because either the companies didn't believe in what Törmälä and his colleagues had done, or they offered ridiculous agreements that Törmälä could not accept. The only way to persuade the skeptics was to show the data. In late 80s, Törmälä had already attained the World record in the bending strengths of bio-absorbable pins. He presented those results in a European meeting of bio-materials. But the strength results were so high that the participants could not believe it. One of his competitor from another European country stepped up and said, "I don't believe in your results". In response, Törmälä promised to send him some pins so that the critic could verify the claimed strength of the pins. After coming back to Finland, Törmälä sent some pins. A few weeks later, he got a letter from his European critic saying "*yes, you are ok*".

After initial discouraging response, Törmälä started to establish first manufacturing company with some technical experts in biomaterials and surgeons who had been involved with him in the early research and clinical studies. Törmälä and his colleagues also developed a company that makes small joint bio-replaceable scaffolds and many other products mentioned above. The company is now based in Tampere.

The next challenge was to deal with conflicting goals of the University and Institute of Medical Science. All research centers and institutes in TUT were focused on publications and basic research, while Törmälä and his colleagues had strong research collaborations with the industry. As a result, they had to face the opposition by their peers and the university. Törmälä was fully aware of these expectations from the university. But he was successful in meeting the expectations of the university as well as working with the industry because originally he was from education and was totally a "science man", a basic researcher. In his doctoral thesis, he had worked on molecular movements in polymer change, measuring them with electrospin resonance and nuclear magneto-resonance. Due to his background from Helsinki University, which had a strong culture of research excellence, his first priority was to make high quality research work. However, when he got his first permanent

position in TUT at Institute of Material Science which had very strong linkages with companies, he had to change his attitude and views about science. Nevertheless, he could still retain his interests in the basic research.

To meet the conflicting goals, he was working on two dimensions. First, he was involved in basic research on bio-absorbable polymers. It was very fruitful because it was a new area of science to make new polymers composites for studying their mechanical and hydrolysate properties. So, science was somehow in every case top priority for him as long he was in university. Institute of Biomaterials was the so called spearhead institute. Its researchers were very strong at basic research.

In 1980s, Institute of Material Science had altogether more than 1000 publications; 300 to 400 were peer review full papers and then 600 to 700 international meeting abstracts of various studies. For many years, Institute of Material Science was a leading institute at TUT in terms of number of publications. Second, Törmälä and his research institute had strong and fruitful collaboration with surgeons and medical people then. They were strongly inclined towards developing practical and industrial applications. They developed implants for them to be used in animals and in human patients. They had strong collaboration with other Finnish universities and with tens of universities in Europe and in USA. Through their industrial cooperation, they were successful in earning money for the university. With that money they could develop practical applications, screws, pins and plates for bone fracture fixations and arrows for fixations of knee meniscus ruptures. They had twenty(20) or thirty(30) different kind of products which were developed from those bio-absorbable materials in 1990s and in early 2000. Some of those implants are shown in Figure 4.2.



Figure 4.2: Bio-absorbable screws developed by Pertti Törmälä and Pentti Rokkanen

Source: Hyöty ja tie: Tampereen teknillisen yliopiston historia 1965-2015 (p. 203)

However, Törmälä and his colleagues always tried to operate in ethical manner and ensured that the money is flowing from industry to the university as a result of those collaboration and not the vice

versa. Thus, through their two pronged policy, they were good in both the areas: making high impact publications as well as commercialization of research and could reconcile the conflicting goals of TUT and Institute of Material Science.

The third challenge was the resistance from people around them. Törmälä explained this resistance in the following words:

“always there are people who are very envious. They try to find your mistakes to get rid of you, to make problems for you. But I am happy that I had never ever [had] such problems, because I never took money from university to my companies or to the other cooperating companies. It was always in the opposite direction. That is very important principle even today, I think, many institutions workimportant in Finland.....Helsinki University and Aalto University works with many companies and it is very important that companies pay the costs and the university makes the work. That’s how it should work”.

For Törmälä, the fourth challenge was Stalinist influence on Finnish universities in late 80s. Due to historic factors, it was very difficult in Finnish universities to conduct research for industrial applications in 1980s and in 1990s. Since 1970s, Finnish society had started receiving very strong influence of the Soviet Union. Many young and talented people took Marxist ideas or propaganda of the Soviet Union; they were commonly known as Stalinists or “the children of Stalin”. They tried their best to change Finland to socialistic country. One of their goals was to stop universities, including the technical universities, from working in cooperation with industry or with business. The Finnish Marxists opposed everything which had something to do with Capitalism. When Törmälä started his career in 1975, it was very difficult to make collaboration with companies because of the Soviet Union influence in educational ministry. According to Törmälä, many talented people who nowadays are working for Capitalistic system, as young people they promoted Stalinist ideas and tried to transform Finland into a socialist state. So, in UTA and TUT it was very difficult to work with industry or with businesses at that time. Due to his knowledge, experience and research collaborations, Törmälä could see the emerging trends in complementary research areas including, regenerative medicine. In order to capitalize on the new trends these research areas, Törmälä decided to play his role in promoting the new research field in Tampere.

4.4 The Role of Pertti Törmälä (2000-2004)

Törmälä was involved in joint research projects with partners in different parts of the world. His research engagement in different regions of the world opened new vistas of research. In early 90s, he was involved in his first collaborative research project on tissue engineering with Tel Aviv University(TAU). He developed the scaffolds for seating the chondrocytes cultivation and the Tel Aviv University conducted animal studies with birds to create the new cartilage for knees of a small bird. It was Törmälä’s first exposure to the new field of tissue engineering and according to Törmälä, it was the first time when tissue engineering was applied for making on new cartilage. It was scientific work which gave good results, but it never proceeded to practical applications at that time. However, *“it had the influence that we established Regea Institute of Regenerative Medicine in Tampere...we understood that Tissue Engineering can be very important for future”*, said Törmälä. Recalling his motivation to pursue work in in the emerging field of regenerative medicine Törmälä said:

“Tissue Engineering will be important in near future to create tissue, new cartilage, or new bone. Because we have been working always with bones and that was the main reason to go to this direction. In TUT, we are more bound with materials and I thought if we can have such an institution, like Regea, where we can have people more familiar with living cells, living tissues, then we can bind the material science and science of living cells and living tissues ... to create new tissues...and to replace damaged tissues”.

For many years biomaterials were used for healing fractured bones and other problems. These biomaterials were passive method of healing. They were basically lactic acid which could be turned into stiff structure and screws. But it was a passive process just to repair fractured bones by putting screws there. The screw could get dissolved afterwards automatically, but there was no biological activity. On the other hand, tissue engineering is an active method of healing.

As Törmälä was already involved in a work which could be complemented with the emerging field of tissue engineering, he felt the need for an institution in Tampere working on tissue engineering. So, after his new experience at Tel Aviv University, he started promoting his new insights about tissue engineering research field in Tampere. It is, however, not known when exactly Törmälä started to promote the idea of cell and tissue engineering research in TUT or in Tampere. While claiming his contribution, Törmälä said, *“I was one of the people who made plan for Regea”*.

Some people in UTA and TUT have confirmed the contribution of Törmälä in establishing Regea Institute of Regenerative Medicine and in promoting the regenerative medicine research field in Tampere. For instance, one person working in BioMediTech pointed out that:

“Pertti Törmälä was the person who gave this idea [that there should be an institution in Tampere which should focus on cell and tissue engineering. His influence was to have all the big players in Tampere to get them together and work on this [establishing cell and tissue engineering research center]”.

Although Törmälä and his colleagues faced problem when they were trying to sell their innovative ideas in biomaterials because the people didn't believe in their ideas, they didn't face the similar problems when they started promoting regenerative medicine research area in Tampere, noted Törmälä. He had already established the clinical use of bio-absorbable implants, pins, screws, plates or arrows for connective tissue fixation and they had been used for couple of million people with good results.

“When Regea was established, there were no doubts any more that bio-absorbable could be used successfully in clinical cases by combining with the cells or tissues of different kinds. So, it was more of a question how well then people who start to work this can do the work”, said Törmälä.

Moreover, for establishing Regea Institute of Regenerative Medicine the situation was much more positive than the clinical studies which they started in early 80s for bio-absorbable, because those applications, which Regea started to work with, were much more in demand. So, in the former case, the innovation was not in demand and had a lot of doubt about its possibility and use while in the later case of regenerative medicine, the innovation was in great demand and there was no skepticism, as Törmälä perceived, about the use and possibility of regenerative medicine. Törmälä's perception

was based on his prior experience as he had achieved success with fixation of bones and connectivity to cartilage with bio-absorbable fixation implants. According to Törmälä:

“Our success with bio-absorbable bone fracture fixation implants and with other tissue fixation implants so internationally...had a positive effect or influence that when I had asked the group of discussing about this Regea that this our success gave positive influence”.

In addition, the focus of Törmälä's colleagues at TUT was on applied research. So, they welcomed the idea of new research field which was of applied nature. According to Törmälä, there were also other enabling conditions available for promoting the regenerative medicine.:

“also that Tampere University people believed that this was a good idea to extend the research work from this bio-absorbable tissue fixation implants ... to Regea where living cells will have more big influence to the results than in the case of bio-absorbable implants where when we use bio-absorbable implants in fixation of bone fractures or cartilage fractures or other connective tissue fractures, [In] this [new approach] the main healing comes from tissues as such; our implants, our materials, they help healing and their mechanical properties are also good that they boost or increase the healing grid; but the healing comes from naturalas such, but then in the case of Regea we wanted to go to the next level that also ... can increase the behaviors of tissues and cells in the healing process in addition to using good materials”.

So, Törmälä and his colleagues were already involved in making bio-absorbable implants for tissue fixation. But with the emergence of tissue engineering, the researchers could develop tissue implants using combinations of bio-absorbable and living cells and tissues. Initially it was believed that tissue engineering can produce engineered structures with the help of biomaterials, cells, and bioactive material (taken from the body) which can affect the cell. But through latest development in the field, a new technique called “*tissue inspired tissue engineering*” has emerged where biomaterials are combined with some bioactive materials, taken from human body. So, now human fat (taken from stomach or abdomen of the patient or other healthy person) has eliminated the use of living cells. These techniques can be used to treat wounds, produces the soft tissue, and other defects in the tissue which are beneath the skin. In sum, Törmälä and his colleagues and their work on biomaterials later on became the forerunners of regenerative medicine tissue inspired tissue engineering research field in Tampere.

According to Törmälä, Markku Jarvinen, a professor in Orthopedics, and Professor Riitta Seppänen-Kajansinkko also played important role. During her doctoral thesis, Seppänen-Kajansinkko had research cooperation with Törmälä. Her research work was on bio-absorbable screws which Törmälä had developed for her in TUT with cement for using in animal and clinical studies. The results of these studies were really very good. Törmälä was convinced of her qualities which he described in following words:

“Riitta was very important from the beginning. She was very talented. She made her doctoral thesis already with us using bio-absorbable screws in craniomaxillofacial surgery with good results”.

Although Törmälä was working in TUT at that time, he was lobbying in both TUT and UTA for the establishment of the aforesaid research institute, Regea Institute of Regenerative Medicine. He recommended Seppänen-Kaijansinkko's name to the leadership of UTA and to the University Hospital to lead Regea Institute of Regenerative Medicine.

The next step was to search for the financing from the government and from the two universities of Tampere (UTA and TUT) and to develop research collaboration between the two universities to establish a research institute for regenerative medicine; *“the Regea was one result of this cooperation then”*. Tampere University then invested money to create Regea and from TUT, Törmälä and his colleagues supported it, *“but the idea came from us as such that an institution should be important for Tampere”*, claimed Törmälä.

Törmälä's claim was confirmed by Timo Ylikomi who is the next important actor in promoting the regenerative medicine research in Tampere. According to Ylikomi:

“Professor of bio-materials, Pertti Törmälä, was also involved in the establishment of Regea. He[Törmälä] was asked and was discussed with and apparently he has in his mind in the early 2000 that this kind of center for tissue engineering would be important in Tampere. Later, I learned that he also had an idea. He told me that it was him who mentioned that to Matti Eskola and then process started”.

Ylikomi further noted, *“she[Professor Riitta Seppänen-Kaijansinkko] was just a name for me[Ylikomi] when she was mentioned”*. As Pertti Törmälä had been working on biomaterials, *“so most probably yes”* Törmälä would have recommended Seppänen-Kaijansinkko's name for the proposed research center, said Ylikomi.

4.5 The Role of Timo Ylikomi (2000-2004)

Professor Timo Ylikomi is working at UTA. He did his PhD in the field of hormone studies from UTA in 1987. Then he moved to France (Strasbourg) to pursue his post-doctoral training in one of the leading research institute in hormone research. In 1992, he came back to Tampere, but he continued working on a collaborative project with the researchers in the French research institute. The research team was trying to develop a genetically modified mice strains (“knock-out mice”) in which a receptor for the reproductive functions related hormone – progesterone – was modified. Ylikomi was responsible for generating the gene constructs for establishing the knock-out mice. The researchers in France developed the mice strains and sent it to Ylikomi in Tampere who then was supposed to study the phenotype of the genetically modified mice. The project was supposed to result in high impact publications.

At that time the established models for hormone research were chicken oviduct and mouse uterus. However, during his research, Ylikomi realized that the animal models being used for hormones studies were very simple cell models. They didn't reflect the human biology well. So, he started developing the better models, primarily for his hormones studies, but he realized that the new models would also be important for other purposes, for example, for drug discovery or testing the toxicity of newly developed compounds. During this work, he was involved in exchanging ideas with Professor Hanna Tähti, one of his colleague at UTA. Tähti was a toxicologist. In toxicology, the

researchers test different compounds to see if they are harmful to human. As there was sufficient evidence that the animal biology did not reflect human biology, Tähti had already started in early 90s her work on developing human cell based assays for testing toxicity. Using human cells was a not a well-accepted idea at that time. But she was going counter currents. She had realized that animals were not very good models.

In 1993, Timo Ylikomi read a classic article titled “*Tissue Engineering*” in Science Magazine. Tissue Engineering was an emerging interdisciplinary field having the potential to cure many human health care related problems including loss or failure of human organ or tissue which were very common and costly problems. This new field drew from principles of biology and engineering for developing ‘*functional substitutes for damaged tissue*’. Professors from elite American universities and research groups were proponents of the new ideas. Ylikomi realized the importance of tissue engineering for his current research area. He knew that both chicken and mice had very different reproductive functions and to study the function and the mechanism of action of estrogen and progesterone in human, he would need human cell based model. Ylikomi often discussed these ideas over the coffee with Professor Hanna Tähti and soon realized that they have common views about the advantage of human based models over the existing animal biology based models which were based on very simple cells.

Ylikomi was still involved in the project of genetically modified mice for some years. However, his new research ideas had probably disillusioned him from the work on hormonal effects in mice. In one summer evening in 1996, Ylikomi was working in the university in France when he decided to start research for building human cell based models to study hormone. The new models were complex having 3-D structures to be built in the laboratory. Initially, he wanted to develop them for the models of hormones.

Although he had invested his time, students’ time, money and his credibility, the project of developing genetically modified mice completely failed. It was a big disappointment for him and made him think whether he should continue working in Science. The failure damaged his credibility, mentioned Ylikomi.

Since Hanna Tähti and Ylikomi were working closely in 1996-07, they agreed that the world would need human biology based models. To realize their vision, Ylikomi and Tähti established Cell Research Center (CRC) in Tampere in 1999. The purpose of this cell research center was to start a research area for developing and validating human cell based models. For establishing CRC, they got funding from Finnish Ministry of Education and Culture and Finnish Ministry of Agriculture and Forestry. The environment in the Tampere region was very much supportive for their new research ideas. They were promised that the Faculty of Medicine would build a state of the art cell culture facility for CRC. Ylikomi got similar enthusiastic response from within Tampere region when he started to promote the idea of regenerative medicine.

In 2005 Ylikomi and Tähti got funding from Academy of Finland to conduct a feasibility study for establishing a center for alternatives in Tampere. In 2007, Professor Tuula Heinonen, a toxicologist who had more than fifteen years of work experience in pharma industry, was invited to University of Tampere to transform CRC into Finnish Center for Alternative Methods. On the basis of the feasibility study, the CRC was turned into Finnish Centre of Alternative Methods(FICAM) in December 2008. Heinonen has been leading FICAM since 2008. FICAM develops and validates cell

and tissue culture 2D and 3D models “to complement and to replace the use of experimental animals”(FICAM, 2017). Professor Kaija Holli, the former head of the Medical school and later the Rector of UTA, supported the establishment of FICAM.

When they established CRC, Ylikomi had no idea that he would soon like to start there another research activity. He realized that the research on human biology based models, which was carried out in CRC, was not sufficient for the long term sustainability because it was a project funded by TEKES. So, other things must be added to their research portfolio.

In April 2001, Ylikomi read another classic article titled, “*Multilineage cells from human adipose tissue: implications for cell-based therapies*” published in the journal “Tissue Engineering”. The article had identified human adipose tissue (body fat) as an alternative source of autologous adult stem cells which could be used for cell-based therapies, such as tissue engineering. He got very enthusiastic about this sub-area of tissue engineering and decided to start new research area aiming at the stem cell research and tissue engineering in the CRC. As a result, the CRC would not only be involved in developing human cell based models but will also develop cell based products for medical care using tissue engineering.

In CRC they were developing models for drugs discovery and toxicity to build human tissue like structures. Ylikomi thought that that the same knowledge and technology could be used to produce tissue products for humans, or to produce human spare parts.

Many coincidences came on the way. For instance, in mid-2000, a new regulation was enforced for tissue banking. According to the new regulation, it became essential to produce the tissue products only in a special environment. As a result, it became necessary for the research centers to establish the clean room facilities.

Similarly, at the same time FinMedi Oy⁵ was promoting the idea amongst various actors in Tampere to apply for a big grant from TEKES for bio-materials, stunts, and Eurological duplex stents. Professor Pertti Törmälä was also involved in developing the proposal for getting the funding for certain screws. Timo Ylikomi bumped into one of their meeting and could propose to include the fat or adipose derived stem cells research part in that project. In one of the meeting for developing proposal, Ylikomi presented his ideas to the audience, but he got a strange response. Recalling the response, Ylikomi said:

“when I started to present in the project meeting in 2001 to physicians from the Hospital, that I would like to take cells here [from abdomen] and to make bone, I am pretty sure that there was a kind of, “what the heck; it’s impossible”. So, I guess that was...[taken as a strange idea]”.

The last meeting for developing proposal was held on 17th December 2001 in the office of the FinMedi Oy. After this meeting, the proposal was submitted to TEKES in a few days.

⁵ FinnMedi Oy is an internationally operating company which provides services related to business development and clinical research in the Life Sciences sector.

Commenting on his first meeting with Matti Eskola, the CEO of FinMedi Oy, which was held on 17th December right after the last meeting, Ylikomi said,

“when....this proposal was finished, so I then sat down on table with Matti Eskola and said why don't we start promoting this Tissue Engineering Center here. Matti Eskola said, yes!!! [Ylikomi snapped his fingers forcefully showing Eskola's excitement about Ylikomi's idea]”.

So, Eskola liked the idea very much because he was convinced that about the great commercialization potential of the new research field which could also create a business niche for Tampere. Approximately two weeks after the meeting between Ylikomi and Eskola, Ylikomi got a telephone call from Kalevi Lauslahti who was a physician and pathologist and had worked for Ministry of Health. But at that time, he was working as a consultant for FinMedi Oy. Lauslahti asked Ylikomi about the possible response of the Universities and other people in Tampere region about the new idea.

Lauslahti further told him that Matti Eskola had shared with him the details of the meeting and Eskola would like to consult the people from the two universities in Tampere and other important people from the whole Tampere region. The purpose of this consultation was to know how tissue engineering and stem cell research would fit and how would people respond to the idea. Lauslahti had worked before in a hospital. So he had very good contacts with physicians. He immediately started consulting various actors. Ylikomi and Lauslahti were regularly meeting to share the outcome of the consultation process and to discuss the options to take the idea further.

Legacy of research on biomaterials conducted by Prof. Pentti Kettunen and Pertti Törmälä became enabling condition, an appealing history of Tampere which Prof. Timo Ylikomi could capitalize on when he started promoting the idea of regenerative medicine in Tampere.

Törmälä and his colleagues' development work was reported in the medical literature. For instance, in the late 80's, when Timo Ylikomi was in his medical school, he learnt about their work. So, when Ylikomi started promoting the idea of regenerative medicine research in Tampere, he presented the new ideas as a continuation of a story of tissue engineering in Tampere that started in early 80's by Törmälä and Rokkanen. In his presentations, he proposed that the people should continue the story by going into the newly born field of real tissue engineering. In the new field of tissue engineering, one would not use just passive biomaterials, but cells, biomaterials and bioactive compounds. A part of his presentation is shown in Figure 4.3(below) which indicates that with his diverse projects, Ylikomi was also trying to develop a sustainable ecosystem of teaching, research, and commercialization in various areas. He was of the view that if there is only one project, it could end soon. Therefore, it was necessary to pursue projects in various areas. To achieve his goal, first he along with Hanna Tähti established Cell Research Center (CRC), then he lobbied to establish clean room facility, which was part of the required infrastructure, and for commercializing certain research ideas, he established an entrepreneurial venture called ChipMan.

Emphasizing the need for collaboration between academia and practitioners for establishing the new research areas, Ylikomi reminded the people that in Tampere there had been a long history of collaboration between the clinicians in hospitals and the TUT for developing different types of biomaterials. Also, there had been a long history of the research and manufacturing facilities for

developing those biomaterials. The bio-materials studies had been important in Tampere since 1970s. He emphasized that those collaborations and facilities were the strengths of Tampere region and must be capitalized on for exploring further possibilities of research and innovation. However, this time the Medical Faculty of UTA could play significant role as its researchers' knowledge about cell and cell biology can complement with the knowledge of bio-materials and the knowledge about the clinical problems. This could lead to new possibilities of clinical work.

Ylikomi approached the Chief Administrator of the University, Timo Lahti, to get his support in establishing regenerative medicine research field. After the Rector of UTA, Lahti was the most important person who was very much involved in the financial matters of the UTA. Before that Ylikomi had sought Lahti's favor and financial support in establishing CRC. So, Ylikomi continued his lobbying work and successfully persuaded Lahti for supporting regenerative medicine research. Lahti agreed with Ylikomi and said, "it is good idea and let's go ahead".

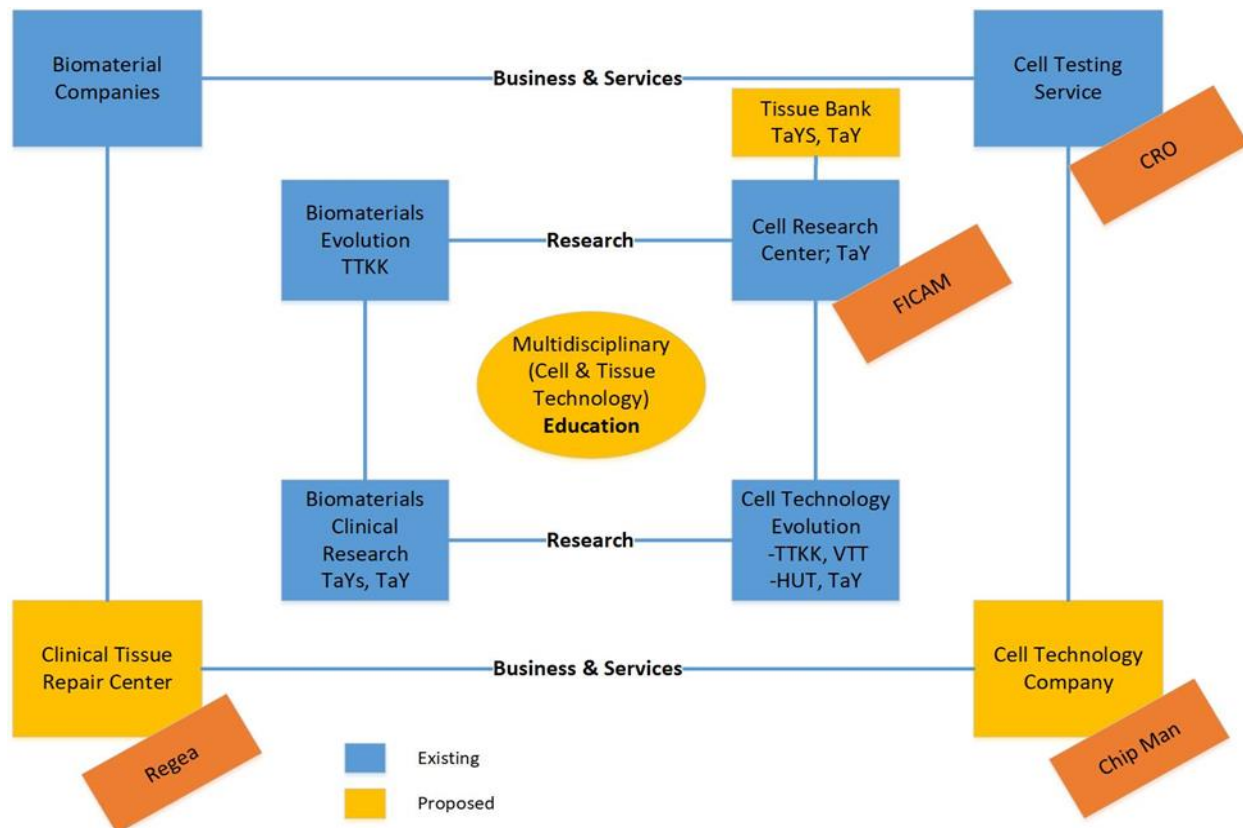


Figure 4.3: Ylikom's vision

In 2002, TEKES approved the funding against the research proposal which was submitted in December 2001. Partners in the project were Tampere University Hospital, TUT and Ylikomi's research group at UTA. However, only Ylikomi's sub project was dedicated on fat derived stem cells to develop bone or cartilage. Other projects were working on biomaterials and stents. Ylikomi got funding through TEKES without any objection or clarification. For stem cell research, the total funding was 150K Euros per year. Real research work on adipose derived stem cell started in

Tampere in October 2002, once Ylikomi got funding through TEKES. Annu Markanen who was a student of Ylikomi was the first person who actually started to work on stem cell.

Annu worked for one year. However, by the end of 2003, she then had to leave Tampere due to family reasons. Thereafter, Susanna Miettinen, another PhD student of Ylikomi, continued with the project. Before starting the work on the new project, she had carried out her doctoral studies on cancer research in Ylikomi's group.

On the basis of the collaboration between Ylikomi and Lauslahti and their lobbying work, which lasted almost one year, they were successful in involving UTA, Tampere Hospital, TUT, and the City of Tampere. Ylikomi, Lauslahti, and Eskola had promoted the idea in all the important circles of Tampere. Eventually, people started feeling the need of a joint effort to materialize this idea. They further felt the need to establish a Steering Group.

4.5.1 Steering group

In order to expand the research in the area of regenerative medicine, a steering group was formed in 2003. Members of the Steering Group were Timo Ylikomi from Medical Faculty of UTA, Professor Minna Kellomäki from TUT, Erkki Kujansuu from Tampere University Hospital, and Kalevi Lauslahti from Ministry of Health. In addition, representatives of Pirkanmaa Hospital District⁶, Pirkanmaa University of Applied Sciences⁷, Coxa⁸, and City of Tampere were also part of the Steering Group.

The Steering Group attended a coaching session from a business consulting company in Tampere. During the coaching session, Ylikomi and his colleagues were asked different questions including the possible legal status of the proposed research institute, for instance, a private company, a cooperative, or part of the University. Matti Eskola, CEO of FinMedi Oy and Pertti Törmälä were also other key actors who advocated the big players in Tampere to join hands together and work on regenerative medicine research.

For almost one year, the Steering Group met once a week, deliberated on various ideas including the purpose, timing and the place of establishing the new research institute. Timing of establishing the institute was one of the important question because they also thought that it might be too early to establish such institute. Initially, they thought that it would be a laboratory work as usual. But very soon the group found out that they would need a Clean Room Facility as it was the important legal requirement to conduct tissue engineering research and to transplant the resulting products to the human subjects. It was mentioned above that in mid-2000 a new regulation was enforced for tissue banking which made it essential to establish Clean Room Facility for producing the tissue products. However, the Clean Room facility was not required for conducting research with animal subjects.

It was further envisioned that if the proposed research leads to innovation, then the innovation would need to be licensed before commercialization. In addition, the value of innovation could be higher if

⁶The Pirkanmaa Hospital District is a joint municipal authority owned by 23 municipalities.

⁷Pirkanmaa University of Applied Sciences was merged with TAMK in 2010.

⁸Coxa is one out of many hospitals in Pirkanmaa Hospital District which provides artificial joint surgeries for Joint Replacement thus also called the Hospital for Joint Replacement.

human subjects were involved than the animal subjects. So, irrespective of the legal status of the tissue engineering research center, the clean room facility was a must as the Steering Group had decided to go for human subjects.

According to Ylikomi, Clean Room facilities started to appear in universities in the mid-2000 and the trend continued. Karolinska Research Institute in Stockholm started to build a Clean Room facility in 2004/5. Also, in UK there were some universities which built Clean Room facilities in the same years. By 2010, many universities started to build Clean Room facilities.

In 2002, the Steering Group conducted a basic feasibility study for Clean Room facility in Tampere. In 2003-04, they had extensive discussion about the cost, vendors, and possible funding sources. Initial estimates were around one million euros. The Steering Group was not only involved in deliberating the ideas but was also involved in the lobbying. Different organizations in Tampere had started realizing the need of the new research field. When the Steering Group came up with concrete ideas and its requirements, important organizations joined their hands to take the idea further. These organizations included UTA, TUT, Tampere University Hospital(TAYS), the City of Tampere, Council of Tampere Region, and the Employment Agency of Tampere. As a result, they successfully got funding for the Clean Room facility, mainly from local organizations in Tampere. In 2005, some of the money came from a program called BioneXt Tampere 2003-2010 (BioneXt, 2010, p.2). The purpose of this program was to promote innovative businesses in Tampere. In 2004, tenders were called for establishing the Clean Room facility. However, due to some procedural delays, it was finally decided in 2005 that a particular Clean Room facility would be bought and installed.

The next challenge was to choose someone who could lead the proposed research institute. Ylikomi was offered the slot but he refused. He recalled the moment in these words:

“I remember the meeting very well that it was very much offered for me first that I could be the head. But at that time....we were in these cell models and tissue models and we had started the collaboration with TUT and VTT... We had started a company in 2002 to commercialize one device which could automatically analyze these models [developed in] the cell research center..... I was involved in that and I was also involved in this cell research center works. So, I was thinking that I could not dedicate all my time on the tissue engineering center; so that I said NO that I cannot do that. I know it hurt very well; it hurt me very much me saying that [because] I have been promoting this [tissue engineering research] center for four or five years and now I could have it. But I had to say, no”.

After the long struggle, Ylikomi was asked to be the head of the proposed research center for tissue engineering, however, he turned down the offer mainly due to his engagement in CRC and in another company called ChipMan, a commercial enterprise which was established in 2002 by Ylikomi and some of his colleagues from UTA, TUT, and VTT to develop and market an electronic device which could automatically analyze cell models and to treat the cell models.

On the role of Timo Ylikomi, Hanna Tähti commented:

“I always remember that.....because we worked together...Timo and me....at the end of 1990 when we started CRC and we were often sitting in the evening and

thinking what could be the future and then Timo got a very good idea which was not realized: Human-on-Chip. Actually, all human cells can be cultivated and nowadays you can also find methods that all tissues of human body are on one chip and you can test different chemicals with them. We can create tissues which are like normal tissues and then of course the start should be stem cells: human stem cells. That was, I guess, was the idea to develop human tissues and then later, for instance, Timo got the idea to use those tissues in practice; for instance, those to cureyou know ...if ...[someone]... get some injuries in the legs you can put new tissues.cartilage.. a kind of practical use also of these tissues. He[Timo Ylikomi] has the most interesting ideas always. So, Timo is not sohe is such kind of researcher who gets always new ideas...he is a very good colleague”.

Professor Pertti Törmälä and another professor of TUT had a name in their mind to lead the newly established research center. They knew Riitta Seppänen-Kaijansinkko and considered her the most competent person for leading the new research area. So, they proposed her name for the task. Installation of Clean Room Facility was in last phase when Seppänen-Kaijansinkko joined and took over as the Director of the newly established research center, later named as Regea Institute of Regenerative Medicine.

4.6 The Role of Riitta Seppänen-Kaijansinkko (2003-2010)

Professor Riitta Seppänen-Kaijansinkko is an oral and maxillofacial surgeon. She joined UTA in 2003 as Director of a project for working on tissue engineering and as a professor of medical biomaterials. From 2007, she started working as a professor of tissue engineering research. She was appointed by the Steering Group and was working under Medical Faculty of UTA, but she also became part of the Steering Group. She was given the task of founding the institute for tissue engineering. There was lot of discussion on how the tissue engineering unit would be positioned: under the faculty of medicine or as a distinct unit in UTA. Finally, it became as a distinct unit in UTA and was named as Regea Institute of Regenerative Medicine.

Timo Ylikomi was involved in stem cell research by supervising Susanna Miettinen's work on stem cell. Moreover, he was involved in many other areas. But soon he realized that he should have focused his research on one particular area. So, he gave the fat derived stem cell research to Regea. Miettinen who had so far worked with Timo Ylikomi on stem cell research joined Regea in 2004. So, Miettinen was the pioneer researcher in Regea. Although Ylikomi had not experience of working in the stem cell research, but he remained involved in stem cell research for almost six months. He was invited for the meetings just because he had confidence, which had stem from his belief that “*if somebody else can do it, we can also do it... [Ylikomi expressed his joy while sharing his thought] So, we can do it*”. However, once Ylikomi realized that a team was ready to work under the leadership of Seppänen-Kaijansinkko to take the idea further, he completely abandoned pursuing it.

Seppänen-Kaijansinkko played a multidimensional role in promoting regenerative medicine research field in Tampere. All of the interviewees in this case study confirmed her role and contribution. She was not only a formal head of Regea, but she also provided functional leadership because she was very much involved in the research itself. In addition, she is an outspoken and eloquent speaker who

can really express herself and can convince people. Therefore, she actively promoted the whole idea of the fledgling research field to different stakeholders. Miettinen confirmed her role in these words:

“Riitta had a huge role. She was the key person of Regea. in gathering funding and then in kind of increasing public awareness of research area. That was really important.... she was having many many presentations in this kind of public events.... not just media but in all kind of meetings, social events that kind of things.... I believe that it[her efforts] had some role. But she was really the key person in building up the research area in Regea”

According to Timo Lahti, who was the Chief Administrator of UTA and also one of the member of the board of Regea:

“Riitta was the key person; she had a talent to sell this idea; she was very active in international fields and meetings...and was innovative”.

Lahti further commented that Seppänen-Kaijansinkko was one of the member of the Board of UTA as an expert. Board interviewed her. After interview everyone thought that she was the right person for the task of creating a new research unit in UTA. So, the Board was convinced of the need to appoint a person to promote cell & tissue engineering research field. Her main contribution was the establishment of Regea Institute of Regenerative Medicine. This was acknowledged by the TUT, which honored her with the title of Dr. Tech in 2012.

4.6.1 Establishment of Regea Institute of Regenerative Medicine

Regea Institute of Regenerative Medicine was started in 2003 as a research project focused on cell and tissue engineering as part of Institute of Medical Technology (IMT) at Finnmedi campus of UTA. Professor Riitta Seppänen-Kaijansinkko was the Director of this project. IMT was a big institute comprising of more than hundred people and was headed by Olli Silvennoinen. But Regea started with only three people, Riitta Seppänen-Kaijansinkko, Tiia Tallinen, and Annika Hakamäki. However, it grew very fast. In 2004, it became an autonomous research institute at UTA. Regea was so named on the proposal of Seppänen-Kaijansinkko. Amongst its founders were UTA, TUT, Pirkanmaa Hospital District, PIRAMK University of Applied Sciences, and Coxa Hospital for Joint Replacement.

Timo Ylikomi was the first researcher in 2004 supervising Susanna Miettinen's post-doctoral researcher work on fat derived stem cells (a sub area in cell and tissue engineering) to develop bone or cartilage. Soon, Miettinen joined Regea and left Ylikomi's group because Ylikomi had decided to leave everything to the new leadership of Regea.

There was a research tissue bank on the campus. In 2005, a clinical tissue bank was also established in UTA. Regea was also the only multi-tissue bank in Finland working under the leadership of Seppänen-Kaijansinkko. Regea procured transplant and provided them for clinical use. The same year, the researchers in Regea started with first bone transplant, then followed with cranial transplant, amniotic membrane transplant, and stem cell transplant. They also started to import certain types of tissue transplant for clinical use. Susanna Miettinen had developed the technology of turning adipose derived stem cells into bone tissue.

Regea had very supportive culture. While describing newly established Regea, one researcher said

“we were a new and small institute, everything was quite flexible in Regea. Of course, we followed all university’s rules and regulations as such, but it was easy to get things done at Regea because everything was informal at Regea”.

Researchers at Regea had been very successful in getting external funding for their research since 2003. However, the absence of basic funding for administration and research infrastructure was a challenge for them.

Seppänen-Kaijansinkko had strong connections with researchers, practitioners, especially in the areas of bone and maxillofacial surgery, and companies which were doing business in these areas. In 2004, Seppänen-Kaijansinkko persuaded Professor Outi Hovatta to join stem cell research at UTA on part-time basis to strengthen stem cell research in Tampere. Professor Hovatta, originally a Finn, was an important researcher of international fame working on stem cell research at the Karolinska Institute in Stockholm, Sweden. In addition to her other role, she was able to win one funding from Academy of Finland for regenerative medicine research.

In 2007, STEMFUNC, a consortium comprising of four research group from TUT and Professor Outi Hovatta(UTA), got 912,000 Euros from Academy of Finland for Regenerative Medicine research. Professor Jari Hyttinen, Professor Pasi Kallio, Professor Jukka Leikkala, and Professor Minna Kellomäki were the four research group heads from TUT. The funding was for three years starting from January 2008 to December 2011(AoF, 2007). However, Professor Hovatta left Regea in 2009 and Professor Heli Skottman took over that part of the project. In addition to Skottman, Katriina Aalto-Setälä of Hearth group and Susanna Narkilahti of Neural group were also involved in this project from UTA side. All these groups later on proved forerunner of the Human Spare Parts Project⁹ as Jari Hyttinen aptly remarked, “... in a way our human spare parts program started in 2007”.

Although Regea was an academic institution, it was focused on providing solutions to health care problems of real life. Its motto was “From research to clinical care”(Regea, 2008b). Regea has been dealing with all the operations for “*the handling, preservation, storage, and/or distribution of human-based tissues or cells. It processes and supplies tissues (bone, tendon, amniotic membrane, sclera and cornea) for clinical use. It also produces adipose tissue derived stem cell products for the treatment of bone defects, the so called Advanced Therapy Medicinal Products(ATMPs)*”, following Good Manufacturing Practices (GMP) guidelines. The National Agency for Medicines conducted first inspection visit of Regea at the end of 2007. As a result, Regea received its license at the beginning of 2008. In addition, Regea fully complies the national and EU regulations(BioMediTech, 2016b; Regea, 2017).

Researchers at Regea very soon achieved landmark successes in their research field. Through their research in regenerative medicine, they cured their first patient in 2006. The patient had infected frontal sinus. The researchers ossified it, made new bone in that area so that the infection was treated. Then the second patient came pretty soon in 2007. The patient’s half of maxilla (half of the upper jaw bone) was lost due to cancer. It was not possible to cure him with traditional medicines. So, for

⁹ Human Spare Parts is the name of a research project on cell and tissue engineering which was funded by TEKES in 2011. Its details are given in the section on BioMediTech.

the first time in the world a patient's upper jaw was replaced using regenerative medicine(Regea, 2008b). The jaw was developed using the stem cell taken from the patient's own fatty tissue. The operation was conducted in Helsinki. The researchers from Regea Institute of Regenerative Medicine were involved in producing combination of cells and some biomaterial for the treatment. Oral and maxillofacial department of Helsinki University Hospital was also involved in the operation. The scientists produced the new bone for the upper jaw, using stem cells combined with the biomaterials. The mixture was put into a titanium frame to develop the bone according to the required shape and size, which was then placed inside patient's stomach muscle. After six months the contents were ossified and blood vessels were developed into it. The resulting structure was then removed from the stomach and was transplanted on the required place on patient's face. The process of developing the new bone is pictorially shown in Figure 4.4. After the operation, the patient can live normal life.

Seppänen-Kaijansinkko played a key role not only in the above mentioned achievements, but also in achieving the other aims and objectives of Regea. She was successful in persuading Finnish funding agencies to get funding for the research work at Regea. She is also an eloquent speaker, so she promoted the idea of stem cell research to all the stakeholders mainly through her persuasive presentations and speeches at local public events and mass media. Her media campaign created awareness about stem cell and its potential to cure diseases. So, Regea was also positively covered by the Finnish media. In 2007, Regea was mentioned 18 times in press, while in 2010, it was mentioned 32 times (Regea, 2008b, 2011). Seppänen-Kaijansinkko's presentations, media campaign, and land mark achievements may have affected the cultural-cognitive pillar of the institution. The detailed analysis of the institutional changes is given in section 5.6.

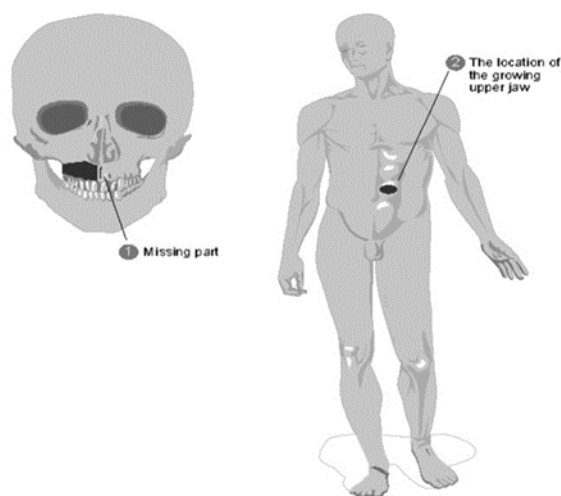


Figure 4.4: Illustration of Upper Jaw Transplant Process

Illustration of the missing part of the upper jaw and the location of the upper jaw inside the stomach muscles (Source: Sotarauta & Mustikkamäki(2015, p.347))

Furthermore, Seppänen-Kaijansinkko was very confident about the potential of the new research field. Although the promoters, including Seppänen-Kaijansinkko, of regenerative medicine in Tampere never showed any data in their lobbying efforts, their confidence in the new research areas

had helped them to win the support of influential people. Commenting on their confidence, Timo Lahti said, *“they were very confirmed”*. Probably due to her confidence, Seppänen-Kaijansinkko was going very fast. Commenting on her pace, Jari Hyttinen said, *“university was ... lagging behind”*. Seppänen-Kaijansinkko officially left UTA in 2014, but she had already reduced her involvement in UTA and Regea due to personal reasons.

However, in 2009, Regea was still facing funding issues and regenerative medicine was still not the main focus area in UTA. Since the establishment of Regea, UTA’s share of funding never rose more than one fifth of the total funding. The situation was evident from Seppänen-Kaijansinkko’s following statements:

“[During the last seven years] the most challenging thing to do is to get funding, since over the years, the university-funded share of Regea's spending has been only about a fifth”(Regea, 2011, p.4, translated from Finnish).

“You have to fight for your interests more and more fiercely in many arenas. Short funding periods are a problem, and the same is true with the dispersion of funds. Funders as well as universities should make more determined decisions on what and who are the focal areas and focus resources accordingly”(BioneXt, 2009, p.18).

4.7 The Role of Hannu Hanhijärvi (2010-2017)

Hannu Hanhijärvi is a pharmacologist who had experience of working in University of Kuopio as a professor of pharmacology and later in pharmaceutical industry. As a vice president of R & D department of a Finnish pharmaceutical company, called Leiras Oy, he worked for ten to twelve years. Later, the company started producing products for international market. So, Hanhijärvi learned the dynamics of international business in pharma and biotech industry. Then he moved to Venture Capital(VC) business and worked with venture capitals for twelve years.

When Hanhijärvi was about to retire from the venturing business, called Sitra, he got a new opportunity. He was a member in the management group of a development program in Tampere, called BioneXt Tampere. The program ran from 2003 to 2010 (BioneXt, 2009, p.7). The closing ceremony of the program was held in Stockholm. Hanhijärvi attended the meeting. During the farewell dinner, Hanhijärvi invited participants’ attention towards the outcome of the program in an interesting way. Hanhijärvi said: *“where is the beef?”*. It took everyone’s attention. Then the Rectors of the two the Universities in Tampere (UTA and TUT) after some discussions, called him and said: *“Hannu! could you find out?”*. It was an invitation for him to look into the ways and possibilities of bringing the two Universities closer for starting research collaboration, strengthening their basic research, and promoting innovation.

Hanhijärvi worked on part time basis as a consultant for a few months for both the Universities. During this time, he interviewed many researchers and group heads in UTA and TUT. He was also working on part-time basis in TUT to run the Institute of Biotechnology. Based on his investigations, he devised a plan which was presented to the Rectors. They liked his plan and asked him to go ahead. Thus in 2011, he was going to establish a new institute.

4.7.1 Establishment of BioMediTech (BMT)

In January 2011, Regea was merged with Institute of Medical Technology (IMT) to form a new and independent institute called Institute of Biomedical Technology (IBT) with an aim to establish an institute of interdisciplinary teaching and research with high international standards. This aim was culminated into Institute of Biosciences and Medical Technology, called BioMediTech (BMT). BMT was established on August 31, 2011 as a joint institute of TUT and UTA bringing together experts from life sciences and medical technology (IMT, 2010, p.27; Regea, 2011, p.5).

Hanhijärvi was the key person in the merger of the two institutes. He was the fully authorize Dean of BMT at UTA, but for TUT part, he had only BMT related authority. More than 250 scientists of BMT were involved in research and education in various areas, including *“cell and molecular biology, genetics, biomaterials, biosensors, computational systems, biotechnology, biomedical engineering, and regenerative medicine”*.

Hanhijärvi played many important roles mainly due to his position, personality, and past experience. First, he played a key role in establishing and strengthening linkages between UTA and TUT. Hanhijärvi took researchers from both the universities and said, *“come on guys! now we have an opportunity, but this time the opportunity is not the way at that you look into your own silo; you look outside”*. So, he encouraged them to promote the real collaboration. One aim behind this collaboration was to develop human spare parts program which was comprised of four groups from UTA and the four groups from TUT.

Second, Hanhijärvi organized a high-level training to develop an entrepreneurial mind-set of the researchers working at BMT. Although it was little tough for some people to participate in a training course, everyone including group heads had to participate in the said training. The trainers were invited from Stanford Research Institute (SRI). SRI has an educational program called, *“Five disciplines of innovation”*. The ideas around which this training was organized are discussed in detail in the book titled *“Innovation: The Five Disciplines for Creating What Customers Want”* authored by Curtis R. Carlson and William W. Wilmot. Talking about the effect of the training Hanhijärvi said,

“So, they understood precisely, what is innovation and how to make innovation, because as you know discovery is not an innovation. Innovation is something what the customer needs and there is a huge step in between and this has not been understood well in the university environment. So now they understood what this is all about.”

In the quantitative survey which was conducted as part of this thesis, the Figure 4.5 shows the responses of the seven senior researchers who have worked in regenerative medicine and who also attended the said training.

This graph clearly shows that the Hanhijärvi's policies had some impact in changing the *“shared understanding”* of the researchers, or the cognitive cultural pillar of the institution. The detailed analysis of the change in the *“software of the mind”* or the change in the cognitive-cultural pillar of the institution is given in Section 5.6. One researcher acknowledged Hanhijärvi's role in this regard:

“Hannu Hanhijärvi was an important person to promote the innovation aspect in the university”.

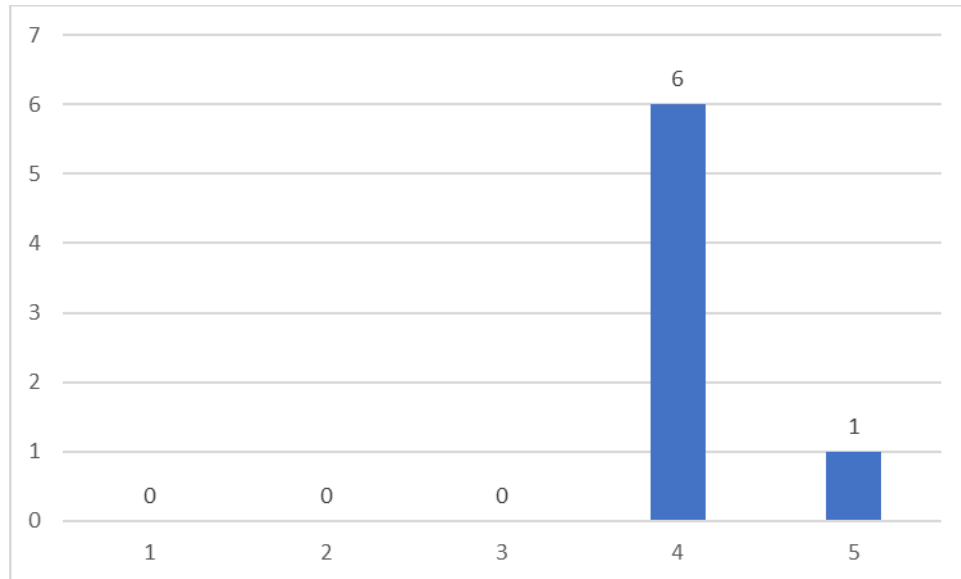


Figure 4.5: Impact of Training Provided by SRI

Survey item: “Training provided by Stanford Research Institute (SRI) has affected my approach toward research/science” Six respondents “agreed” with the statement while one respondent “strongly agreed” with the statement.

Third, using his network, Hanhijärvi approached TEKES to arrange money for the research groups. TEKES had started a new program titled, “Strategic Research Program”. Consequently, he was responsible for the projects of both the universities. In order to persuade TEKES authorities, Hanhijärvi adopted straight forward approach:

“we told that this is the issue where we say it’s not only research but we want to have product; we want to develop product. It is payback time now for the university. So, back to society something value. TEKES loved the idea. So we asked Euros 10 million and they gave us 10 million (he laughed loudly expressing the success of his approach). So, that was a good start”.

Furthermore, in June 2011, he successfully got 750,000 Euros from Council of Tampere Region for buying some equipment (BioMediTech, 2011). Altogether, the Council of Tampere Region provided more than 4 million Euros during 2011-18 to BMT for various development projects, including the large infrastructure projects.

Fourth, Hanhijärvi played a key role in eliminating funding disparity between various research groups who joined BMT from Regea and IMT and provided them a level playing field. Before the merger, Regea had crossed 66 people altogether in 2010 and its total budget was only Euros 3.5 million. Amongst the main sources of funding were TEKES(31.8%), funds from operations (20.6%), basic funding from UTA (18.3%), Academy of Finland (11.7%), and from other miscellaneous sources (12.7%) (Regea, 2011, p.5-6).

IMT was established in 1995. In 2010, it was bigger than Regea as it had fifteen research groups and two affiliated groups with altogether 171 staff. This staff included project leaders, senior and post-doctoral researchers, PhD students, laboratory technicians and support staff. About 73% of the staff were researchers, 21% research support staff while 6% was in administration. Its total annual funding was Euros 11.5 million. UTA was the main source of funding (53%) in the form of basic funding, European Union (6%), Foundations(6%), EVO(4%) and Own Income Financing, University Alliance, etc. (3%) (IMT, 2010, p.5).

From the above figures, it is clear that the IMT was getting Euros 6.095 million from the University (the basic funding) for 171 people while Regea was getting only Euros 0.6405 million from the University for 64 people. So, IMT was getting 3.562 times more basic funding (per person) than Regea in 2010. This is shown graphically in the **Error! Reference source not found. (Error! Reference source not found.)**.

Thus, all the groups in regenerative medicine research were dependent mainly on the money from external sources for their salaries, chemicals and infrastructure. There was little basic funding from the University side. As the Regea was younger institute than IMT, therefore, this disparity could be obvious. But there were other reasons also. Commenting on this disparity, Hanhijärvi said,

“Because they[Regea’s researchers] were [considered] an outside group. They were not really in the University. I pulled them to the University. I put them to the same level as the others. Because I saw that otherwise, because they were the key people to run. The idea of Human Spare Parts was so strong that in the beginning there wasn’t the strong rule. Now we have established these rules. So you cannot join any more, if you are not qualified”.

In 2014, total funding of BMT was approximately Euros 30 million. About 40 % of this money was coming from the two the Universities. Rest of the 60% of the funding (Euros 18 million) was coming from external sources where TEKES(33.8%), Academy of Finland(30.1%), EU(8.1%), and Tutli¹⁰ (5.3%) were the main sources (BioMediTech, 2015, p.8).

¹⁰ TutLi is one of the financing instruments of Tekes, where scientists take the development of an idea further while preparing for the commercialisation of the idea as a new business.

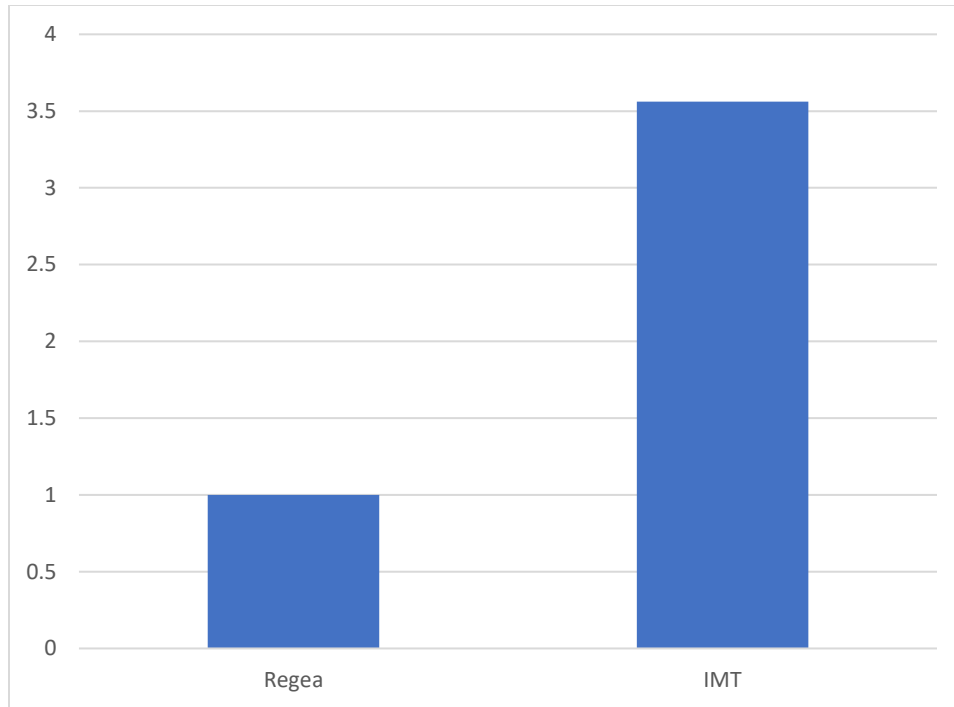


Figure 4.6: Basic Funding (per person) from UTA in 2010

Source: Annual Reports of Regea Institute of Regenerative Medicine and IMT (2010)

In 2010, combined external income of Regea and IMT was approximately Euros 6.93 million from Academy of Finland and TEKES (Regea, 2011, p.6), while in 2014 the external income of the research groups of UTA from Academy of Finland and TEKES was approximately Euros 9.13 million (BioMediTech, 2016a, p.9). The main increase came from TEKES and the research groups working on cell and tissue engineering were the recipient of this added funding. However, it is not precisely known the ratio with which the basic funding from UTA increased for the research groups working in BMT. Out of 15 research groups of IMT, 11 merged into BMT. Only one of the group of IMT had TEKES funding before merger. After the merger of IMT and Regea, if the funding from TEKES increased, cell and tissue research groups (known as regenerative medicine research groups in 2011) were the key recipients because these groups were involved in multidisciplinary research with clear motto of “from research to clinical care” (Regea, 2008b, p.3). The motto shows that regenerative research groups were involved in applied research focused to provide solutions. Hanhijärvi capitalized on the aims of these groups and on the TEKES’s new funding strategy to win funding for human spare parts project.

4.7.2 Human Spare Parts Project

In 2011, eight research groups submitted a research proposal to Strategic Research Program of TEKES to work on human spare parts. Four of these groups were regenerative medicine research groups of UTA and the rest of the four groups were from TUT. Details of these groups are given at Appendix 2. Hanhijärvi played a key role in persuading TEKES. As a result, TEKES approved Euros 10 million for a period of July 01, 2011 to December 31, 2018. This funding was a major breakthrough and a great success for the researchers of UTA working on regenerative medicine. In this program, researcher from various field of physical and biological sciences are using stem cell

to replace degenerated and damaged body parts. In 2015, human spare parts program had more than 140 people working in various capacities (BioMediTech, 2017).

In sum, Hanhijärvi helped to increase external funding and removed the disparity between the basic funding for research groups in Regea and IMT, once the groups were merged in BMT. After the merger, every research group started getting the same basic funding. One researcher working in BMT confirmed Hanhijärvi's contribution in these words: *“So that was the problem [low basic funding] and BMT fixed the problem”*. In addition, funding from external sources also increased, especially from TEKES because BMT's mission was in line with the Strategic Funding policy of TEKES.

Fifth, Hanhijärvi first made some researchers as the group leaders. In January 2015, he applied for a competitive funding from Academy of Finland. The aim of this funding was to help the universities to build a profile in the areas of their choice. He chose three areas of BMT, namely cell and tissue technology for human spare parts, strengthening of FICAM (Finnish Center for Alternative Methods), and strengthening of bioinformatic. He was successful in getting Euros 4.75 million funding against his proposal (AoF, 2018). Due to this funding, UTA created seven tenure track positions and two post-doc positions. Four of the tenure track position were opened in 2015 and two were opened in 2016 for application from two research groups of TUT and two groups of UTA which were cellular and micromolecular biology and regenerative medicine (BioMediTech, 2016a, p.7). So, there was an open competition for the professorship and on the basis of the competition some of the group heads working on regenerative medicine research got professorships. They were strictly evaluated on merit for qualifying the professorship, however, Hanhijärvi played a key role in creating the opportunity of professorship. As a result, some young research group leaders in regenerative medicine became professors.

Sixth, Hanhijärvi developed a mechanism for supporting the research and commercialization activities in BMT. These services included business development, intellectual property right and legal services, quality and regulation, project management, commercialization, and communication (BioMediTech, 2015, p.9). He hired several project managers, one project manager for each project to ensure the monitoring and evaluation of each project, and also a manger to support patenting. Comparing the process of patenting before BMT with the new system in place, he said:

“as you know when a researcher made a patent application to the University headquarter, after two years, they[the relevant manager] came back and said, “what is this? we don't understand this”. Yes, that was the practice.

Now, when there is a new discovery, in the project meeting it comes immediately up. My business people and my project managers and my patent persons are there; so they hear it immediately and my patent person goes to the computer and checks superficially what is the situation and then we talk. I get the information also; they make a form and then we very quickly make and the decision will take the discovery for ourselves and start patenting; and we start patenting immediately if you wanted it. So, researchers within the two weeks, they have the permission to publish. So, there is no slack and they love it. Of course. So, it really works”.

Seventh, transparency was one the important principle of Hanhijärvi's governance. He was openly reporting all the achievements and all the things which were performed. In addition, he established

a strict system of researchers' accountability. "It was for the first time that the researchers had to fulfill their promises", claimed Hanhijärvi. He further explained the new scenario in these words:

"if the biomaterial person promises that by next March I will have some new modified biomaterial for the stem cell researchers, he has to have it. Otherwise, he is in trouble, because I have the money, not he. So, if he doesn't perform, he is cut and of course there are problem and we understand problems. But if there is no performance, then there is no chance".

Moreover, the project managers ensured that the promises to funding agencies were met in terms of time and deliverables. He expressed the new situation in following words:

"then of course everything was very different from what has been done before because now I had a project manager, several project managers. For each project in the program, I had a manager and he was responsible that those promises which were written into the plan, they were kept".

As a result of Hanhijärvi's policies, BMT grew very fast and there were more than 300 researchers in the institute and 30 research groups in 2015 (BioMediTech, 2016a, p.5). BMT became an attractive place to work in. More and more groups wanted to join BMT. However, membership of BMT was then approved by BMT board. For membership, submission of a formal application became mandatory. The applications were evaluated on two important criteria. The aspiring group had to have its basic financing in place and the group should have very good track record of research.

On the outcome of his policy of promoting applied research, Hanhijärvi commented in these words:

"... the early start was very tough. However, it started to work out. The people started to understand the significance of meeting promises and the time schedules. They started to love it; they really love it, because there was some action in it".

Explaining the achievements of BMT, he said:

"we can nowadays make huge pieces of bone from stem cells which we may put to the patients. We also do knee cartilage repair utilizing a new biomaterial, we do female urinary incontinence, we are developing corneal of tissue and so there a lots of things happening".

Researchers in regenerative medicine research groups had treated twenty four(24) patients till 2014 by developing their defective or diseased bones using stem cell technology (BioMediTech, 2015, p.31).

Moreover, research collaboration between researchers of Medical Faculty of UTA and researchers of TUT further strengthened. On the other hand, UTA accepted the groups working in BMT as a separate entity. After four years of Hanhijärvi's joining, they applied for another funding of 8.0 million Euros which they successfully got. Six years collaboration between UTA and TUT has helped the BMT to expand. In January 2017, Hanhijärvi got retirement from his job in BMT.

4.8 Establishment of Center of Excellence for Body-on-Chip Research

From January 2017, BMT was merged with Faculty of Medicine which is now a huge institute with 600 people. The Dean is Tapio Vesakorpi. However, six groups of BMT are still working on Human Spare Parts Project of TEKES. Three of these groups are from UTA and three are from TUT.

In 2017, a consortium of these six groups has won the prestigious Center of Excellency status awarded by Academy of Finland. The Center will now be called as “Center of Excellence in Body-on-Chip Research”. Professor Minna Kellomäki(TUT), Professor Katriina Aalto-Setälä (UTA), Professor Jari Hyttinen (TUT), Professor Pasi Kallio (TUT), Professor Susanna Miettinen (UTA), and Professor Susanna Narkilahti (UTA) are the research group heads in the new Center of Excellence(AoF, 2017). Academy of Finland calls applications after every three years for awarding this status to different consortium. In 2016, Academy of Finland received 179 letters of intent from various consortiums. Out of 179, only twelve (12) applications were successful in getting the award. The Center of Excellence status has been awarded for eight year for the period 2018-2025 and is effective from 1st of January 2018(AoF, 2017).

Announcing the CoE award, Professor Heikki Ruskoaho, Chair of the Academy Board, said:

“The goal of the CoE reform was to encourage the scientific community to propose bold new ideas for cutting-edge projects where researchers carry out joint research plans in close collaboration. Judging from the results, we were successful in achieving this goal. The teams have clearly challenged themselves to adopt new ways of thinking. The new CoEs are units that represent a high scientific standard and that can contribute to the renewal of research” (AoF, 2017).

As part of the award, the consortium will get funding for research. The award will increase the role of host universities in the funding and will ensure longer-term funding and scientific risk-taking from the host universities(AoF, 2017).

One group head in the new CoE was very optimistic about the future due to their landmark achievement. They hoped that the award will “make the situation easier”. Explaining the evaluation criterion for awarding CoE status, one group head said, *“we had a great study plan(research plan) for our consortium and then the applicants were experts in their area. So, we had pretty strong CVs in our application”*.

5 Case Study Analysis

In this chapter first various social, cultural, or structural conditions are drawn out using the theoretical framework discussed in section 2.7. These conditions can be called as institutional constraints. In the section 5.2, institutional enablements are discussed. Then in section 5.3, it is explained how various actors were exercising their agency to deal with those institutional constraints and enablements. So, in this section actor's motivation, passion, and commitments, projective imaginations, internal conversations, and past experiences are discussed. In section 5.4, the role of actor's social position is discussed in relation to their effectiveness in playing the key role. In section 5.5, the strategies employed by the key actors promoting their vision and to rally support for their envisioned future are discussed. Finally, in section 5.6, it is analyzed to what extent the new field of regenerative medicine research has been institutionalized in University of Tampere.

5.1 Institutional Constraints

It has already been discussed in the chapter on literature review that institutions offer certain constraints and enablements to the actors operating within them. It is therefore important to identify what constraints the researchers who were promoting regenerative medicine research filed in Tampere faced during their struggle. The most important constraints which different interviewees have identified were skepticism about the possibility and potential of the new field, conflicting institutional missions, absence or low support from the universities (for instance, absence of tenure for new researchers and low basic funding), conflicting expectations on researchers, and difficulty in establishing the collaboration between UTA and TUT.

5.1.1 Skepticism

In this section, two types of skepticism about regenerative medicine are described. In the beginning, when Timo Ylikomi started promoting his new research ideas in UTA, he was confident and passionate about the new research field. But he didn't get an encouraging response, because people were not ready to take the risk of getting involved in a new multidisciplinary field whose outcome were doubtful. He used a simile, "*fighting against Brezhnevism*" to describe the early response which got when he shared his ideas about the regenerative medicine with some important people in Tampere. Explaining the simile, he said,

"Leonid Brezhnev become the head of The Soviet Union in the late 60's. He was the incarnation of stagnation in USSR and was the protector of the policy that finally ruined the whole country. There are studies on big and wealthy historic empires that have collapsed. One important feature of these countries [was] that before the collapse, dystopic view about the world had taken over in these countries".

Connecting this story to the situation he faced, he said,

"this reminds me of the response of some of the important people in the beginning of 2000's when I explained about the cell and tissue engineering[regenerative medicine]: "in Tampere one cannot develop tissue engineering products to be used in clinical medicine" "Too expensive, too difficult..... too something. It is like developing drugs here – impossible.....".

Similarly, when Ylikomi tried to persuade another important person in Tampere that they should start focusing on regenerative medicine for making tissue engineering products for human treatments, he got the same response:

“this is something.....one should not spend time on this because it is very questionable whether that would ever go ahead and whether it would succeed. It’s too expensive; in Tampere there is never a possibility of doing this kind of work. ...You[Timo Ylikomi] should do something which is more sure”.

In the beginning, thinking about regenerative medicine seemed a science fiction to some people. Explaining the response of one of his colleague he said,

“I remember, once I was discussing with my colleague and she was looking at me[strangely] and.....[Ylikomi made funny face to describe his colleague’s response]”.

She further advised Ylikomi,

“Why don’t you do something more sure, because [she said] she is doing only the things which are sure which bring only sure results and that’s how she survives. So why don’t you[Timo Ylikomi] do the same. Because what you are talking ... sounds very very strange and it has many risks and I think it might not even work. I would never do that. Why don’t you[Timo Ylikomi] just start doing sure things?”.

Timo Ylikomi had read that new human bones can be developed by taking human fat, from abdomen for instance, processing it in lab, and then putting back into the person. Although later on, Susanna Miettinen and Riitta Seppänen-Kajansinkko developed this technique, many people were skeptical about the new ideas, as Ylikomi put it:

“In that time, it sounded a quite a very bizarre that how you can you get something from here [Ylikomi pointed toward his abdomen] and how you can manipulate that somewhere and then you can put it back into human and make something else, meaning bone”.

Explaining the role of Ylikomi in promoting regenerative medicine research and whether or not Ylikomi got support from other people, Professor Hanna Tähti said:

“I guess, not always. But always it is so that Timo may give good ideas to others, but then other hear, cannot understand it, so, I guess, Timo is glad if he can give good ideas to others. He is just kind of a person.Some think that Timo is a little bit not on ground, a little bit in air with his thoughts”.

Responding about the doubts, Tähti said,

“At the beginning, yes[people were skeptical about regenerative medicine research] and may be still some are. It is the same as people are still skeptical that invitro methods could replace the usual experimental animals”.

Recalling the response of a group of some physicians, Ylikomi said:

“when I started to present in the project meeting [where they were making proposal for TEKES] in 2001 to physicians from the Hospital that I would like to take cells here [Ylikomi pointed towards his abdomen] and to make bone, I am pretty sure that they thought in their minds, “what the heck;... it’s impossible”... [Ylikomi laughed loudly explaining it].... So, I guess that was...[taken as a strange idea]...”.

Nonetheless, despite skepticism about the Ylikomi’s proposed ideas, nobody ever opposed the inclusion of regenerative medicine research [adipose stem cell] component in the proposal submitted to TEKES. So, in 2002, Ylikomi got the required funding from TEKES. This was the first ever funding given for regenerative medicine in Tampere by a funding agency.

Regarding the doubts about regenerative medicine in Tampere, one interviewee commented in the following words:

“The problem was that we tried to institutionalize the business before the science was institutionalized. That is one of the issue all the time, you try to sell something, you don’t have yet, and you don’t have words to describe it. We tried to commercialize everything here in Tampere but failed, because the science was not mature enough yet”.

Explaining the reasons for discouraging attitude from the senior professors, the interviewee said:

“If you have really great science stars who are publishing a lot and have been cited a lot compared to somebody who is trying to find a new field, [then]it’s always [the case to face opposition]”.

Regarding the slow response from businesses and university administration, Sotarauta and Mustikkamäki (2015, p.349) have noted that it was not a strange situation because in science-based innovation, it is always difficult to persuade people outside scientific community who have resources. It is difficult for the inventor to explain their ideas to the business community when the ideas are in a nascent phase. Although it was hard to believe in and take the risks of getting involved in the new research ideas for the influential people in UTA, regenerative medicine had been gaining attention of global scientific community as “Panacea” for all kind of health care related issues.

Globally the scientists had diverging views about regenerative medicine. Sotarauta and Mustikkamäki (2015, p.349) have noted that on the one hand were commentators who predicted that regenerative medicine would become third form of medical treatment alongside medicine and surgery. As Susanna Miettinen put it,

“from 2004-07, there were so high hopes that stem cell[regenerative medicine] would treat all the diseases and all the traumas in the world. So, everybody expected that they are now big solution for things”.

In 2007, Academy of Finland awarded 0.912 million Euros funding to a consortium comprised of five research groups. Professor Jari Hyttinen and Professor Outi Hovatta who were working in

regenerative medicine research in Regea, were the two principal investigators leading separate research groups in the consortium. The other principle investigators leading their own research groups included Professor Minna Kellomäki, Professor Jukka Leikkala, and Professor Pasi Kallio from TUT, and two co-principle investigators Professor Katriina Aalto-Setälä and Professor Susanna Narkilahti from UTA. The funding was a sign of confidence on the part of the funding agency.

Sotarauta and Mustikkamäki (2015) has noted that on the other hand were the commentators who claimed that “*regenerative medicine is full of empty promises and more hype than actual treatments*” (p.349). So, globally the hope from stem cell(cell and tissue engineering) started declining after some time. Susanna Miettinen described the changing situation in following words.

“But then it gradually changed. People realized that it takes time to develop new treatments since stem cells are kind ofthey are treated as drugs. So similar developmental path has to be followed with stem cells as there is with drugs. So, it takes time and the success percentages is pretty similar to drugs development. So that when you start to developing some treatment you might not succeed every time. ...I don't think there were that many failures but when researchers reached stage when they had to do clinical trials and the people realized it, how much time and how much funding it will require that might have changed[hopes]. There were probably some failures which showed that stem cell will not that effective, but then I am not sure whether there were.....well! you could say there were failures but I think biggest thing was that the researchers realized that it will take funding and time before these are actual treatments; it won't happen in ten years, it will probably happen in twenty years, but it takes time”.

In 2009, three important things converged and led to a new wave of skepticism about regenerative medicine research in Tampere. First, around the world the expectations from stem cell research had already started declining. Second, Professor Outi Hovatta, the eminent researcher from Karolinska Institute, Stockholm, Sweden, who was working on part-time basis left Regea Institute of Regenerative Medicine. It was a setback for Regea. Responding to whether it created doubts about regenerative medicine research in UTA when Professor Hovatta left Regea, one key respondent said, “*yes. I think so*”.

Third, there were many changes in the governance of the UTA in 2009. So, in 2009, Hannu Hanhijärvi was given the task by the Rectors of UTA and TUT to evaluate the research and commercialization potential of various research groups including the regenerative medicine field in Tampere. Describing this as a dilemma, one professor, using metaphoric language, said:

“I think that.....Prophets are not Prophets in their own country.....he laughed loudly while expressing this].....you know this. So, we professors here say that this is really something that we should do. Then of course they[the leadership] don't. They wanted to have a second opinion from outside”.

Another researcher working on regenerative medicine supported the above views in following words:

“I think for University of Tampere it was a new thing, the field of cell and tissue engineering and regenerative medicine; it was a new thing for the university and I think they were wondering whether it was something that they wanted to invest more in”.

Another researcher put it in following words:

“there might have been doubts because the research area was so new; we didn’t have that high ranked research papers, for example. The field of Tissue Engineering and Stem Cell research, the impact factor for the paper weren’t that high at the beginning.”

About the task of Hannu Hanhijärvi one researcher commented:

“[leadership of the university thought] what could be done with the field of cell and tissue engineering including regenerative medicine at UTA? Hannu was given that task to explore what is going on; what is this new field, you know, and what they have accomplished and I think that he was given the task of evaluating whether it was of worth for the university to invest more in this field. So, that’s what he started doing. He started doing commercial potential and research potential. ... I think Hannu was appointed to look at this idea. To see, Is there any idea or point.then he was named the director of BMT which was established in 2011 and Regea became part of BMT”.

Responding to a question on doubts about regenerative medicine research in Tampere, Hanhijärvi claimed, *“yes, precisely there were doubts”*. He further said,

“You see, it was a very close call in a way that the whole stem cell research could have disappeared”.

Responding to the emerging doubts about this new field of research, one important respondent revealed that initially there were no doubts because:

“Riitta had a wide launch and large and strong support from University side; from University board side. She was active and wanted to have fast movements ahead. There were no problems for many years; doubts came later”.

In sum, two different types of skepticism were prevailing about the emerging field of regenerative medicine in Tampere. One type was only at the University level due to novelty of the field, but other type of skepticism was due the global environment, namely scientists’ diverging views about the potential of the new field. Both of these doubts could cause influence over the researchers. Thus they qualify the definition of constraints.

5.1.2 Conflicting Institutional Missions

Researchers in UTA were mainly discovery oriented (Sotarauta & Mustikkamäki, 2015, p.349). Therefore, in the beginning for many people it was tantamount to losing their identity and the opportunity to work if they get involved in an applied field of regenerative medicine. Due to this

mind-set, Ylikomi faced opposition and discouragement when he was promoting his ideas about cell and tissue engineering. He aptly summed up this mind-set in following words:

“when I started that in late 90s and I was saying that I am not interested just to making publications and PhDs. I would like to make products, applications, and treatments. So, they say but in universities our main idea is teach and research. So what are you thinking? So then I ... thought why I am talking about commercialization in the University”.

As The focus of the university was teaching, research and publications, Ylikomi tried to achieve a balance between his publications and lobbying work. However, lobbying work for promoting an applied field, irrespective of its social significance, was not valuable for the University, as it is evident from Ylikomi's comment:

“I try to balance them [publications and lobbying], but since they[his discovery oriented colleagues and seniors] ... did not very much appreciate this lobbying work, so I think they think one should not balance things but just do one thing[research and publications only]”.

When Ylikomi was promoting his ideas, Finnish universities had no mission for societal engagement, therefore, it was not possible to sell those ideas which had less research excellence but more societal significance and relevance. Socially relevant research ideas were in conflict with the prevailing discovery focused institutional mission.

However, in 2004, the societal engagement, the so called 3rd mission, became part of the mission of the Finnish universities(Santiago, Tremblay, Basri & Arnal, 2008, p.359). Talking about the inclusion of 3rd mission in higher education as a positive development, Ylikomi said:

“fortunately, now in the 2006/08[it was actually 2004] they included the 3rd category [3rd mission] into the university law so that we have to do teaching, research, and the 3rd is this to help the society; whether it's services whether it's information.....or commercializing things. But it came much later than I started..... But still many authorities in the universities don't appreciate the achievements in that area. This is especially true in filling positions and in grant applications”.

In 2011, when Hannu Hanhijärvi started to lead BMT, he faced the same challenge. Recalling his first meeting in BMT he said,

“When I had my first staff meeting, it was like a Persian market place. Everybody was shouting his own opinion. It was thwart to run, because then there was this big division..... ‘I don't want translation. I only want discovery. I cannot do translation’”

He was further of the view that *“there are science stars who don't understand how great value the science has”*, one of the interviewee recalled Hanhijärvi's view about the influential critics of innovation and commercialization in UTA.

In sum, research culture of the UTA was discovery focused(basic research) and was not conducive for a multidisciplinary field of regenerative medicine. Therefore, the efforts by the proponents of the regenerative medicine research were neither appreciated, nor given the due support. As a result, regenerative medicine research and its groups remained marginalized until Hannu Hanhijärvi started to lead BMT.

5.1.3 Low Institutional Support

Skepticism at macro and institutional level about regenerative medicine research and the conflicting institutional mission in the universities created a challenging context for the researchers who were working on or promoting regenerative medicine research in Tampere. In the resulting context, the universities provided low support to the fledgling research filed. This lack of support manifested in different forms.

First, the major hurdle was lack of basic funding, as one group member put it:

“I think they were expressing it[doubt] in not giving more basic funding to us. I think, I am not sure whether it was actual reason or not; but they could make choices every year when they were making the budget. They could allocate money for Basic Funding of Regea; but they were not making it”.

As mentioned in the previous chapter, Riitta Seppänen-Kaijansinkko had time and again raised her concern on low support from the University. In the last annual report of Regea, released in early 2011, she pointed out that:

“[During the last seven years] the most challenging thing to do is to get funding, since over the years, the university-funded share of Regea's spending has been only about a fifth”(Regea, 2011, p.4, translated from Finnish).

She further voiced her concern in these words:

“You have to fight for your interests more and more fiercely in many arenas. Short funding periods are a problem, and the same is true with the dispersion of funds. Funders as well as universities should make more determined decisions on what and who are the focal areas and focus resources accordingly”(BioneXt, 2009, p.18).

In spite of promising field of research, it was very difficult for the research groups to get financial support from university side. Only Professor Riitta Seppänen-Kaijansinkko and Professor Outi Hovatta were getting their salaries from UTA. For many years the researchers survived mainly on project funding because only one fifth of the basic funding was coming from universities side. According to Jari Hyttinen,

“it took like two years to get more resources on that really kind of start working, not just kind of hobby level, but really some serious funding.....

Riitta got, I think, her salary and a little bit more from UTA. But there were no other, of course, Outi Hovatta was there as well, but I think beyond that there were not very much resources on and if you think that you should now establish RM institute, you should have at least five or ten tenured positions and couple

of tenure tracks. So, of course, it was little bit different time and people thought you should give little bit resources and it will grow around that”.

These financial problems have already been covered in detail in the previous chapter and the disparity is shown in the Figure 4.6. Even in 2017, the total basic funding of each research group of UTA working on regenerative medicine was limited to only one third of the one technician’s salary per year. Although technician(s) have permanent job, rest of their salary come from project funding. In addition, research groups still do not get any basic funding for buying chemicals, equipment etc. All the expenses are met from project funding.

Talking about support from the University, one researcher said:

“I am trying to explain how I am feeling; of course, it is unfair that we don’t get that much support. I think that we ought to get more support and gradually we are going to change the situation. so we are kind of ...(she sighed while expressing her views about).....the funding situation hasn’t been that great in the recent years from the University side. So, I understand that there hasn’t been that much resources that we could get”.

For one group leader, getting funding for the salaries of the people was not difficult as salaries could be managed from project funding, but it was not easy to build the necessary infrastructure through project funding. Highlighting the need for the basic funding, the group leader said:

“you can get quite easily funding for individual researchers of a research project for the salaries of people, but then you need basic funding for the infrastructure and for carrying out all the administrative stuff and so on so forth.... all the time starting in 2004 when we started until 2011 we had a big problem in getting enough basic funding... we were not in the same position as were other institutes at UTA, we received less funding, you know relatively speaking of course, but we received very little basic funding and it was a problem....but the BMT[established in August 2011] fixed the problem”.

The role Hannu Hanhijärvi, especially in changing the funding situation for regenerative medicine, has already been explained in the previous chapter.

Due to lack of financial support from the university, the researchers, especially the group heads have to regularly apply for funding for the continuity of their jobs and the sustainability of their groups. The development and submission of funding proposals took a lot of researchers’ time and energies. Nonetheless, they *“were always successful in getting funding for research since 2003”*

Commenting on the reason of *“very small [funding] from university side”*, one key actor noted:

“Regea was a starting institute. The university, I think, wanted to see how it is managed to succeed in scientific work.... it is very usual in new ideas and new projects and institutes; they start with not permanent funding”.

It is true that the regenerative medicine research was a new field, therefore, it was difficult for the university to allocate the required resources for it, as Jari Hyttinen commented:

“hindsight you could think that..... that it would have been much easier road and more effective road if the University had given couple of position more.they could be more effective, more like stable”.

Furthermore, other research groups, especially in IMT were competing for the same financial resources. Some of those research groups had been in operation since mid-1990s, so they could exercise their leverage for getting funding. Consequently, regenerative medicine research groups were unable to get the required support, as one researcher in cell and tissue engineering research put it:

“unfair treating of Regea vs IMT by the University, even both were “equal” research institute inside university”.

However, it is a paradox that the universities claim to promote innovation, but innovative ideas are not supported when they are in fledgling phase due to their focus on basic research.

Second hurdle was the absence of tenure for the young and competent researchers. Only one out the four research group heads of the UTA was tenured in 2017. Other researchers in their groups are still not tenured except their technicians. However, none of them were tenured before BMT was established. On the other hand, all the group heads of TUT were tenured since the beginning. In terms of tenure, researchers of TUT were supported from their university. Commenting on this situation one group head from TUT said,

“most of us were already established professors before Regenerative Medicines[cell and tissue engineering] and then from UTA side, these persons [the group heads] were younger and, of course, they had not reached that level yet as us. But, of course, you could say that TUT through our professorship had the better support for this. But partially whether you say that it is institutional support or it just happened that we were little bit older”.

Third hurdle was very slow response from the university administration to make the promised changes. According to one group head:

“the main challenge really has been to get this kind of bigger changes to university; not really Rectors, but through university administration; so that has been really very slow; starting from there may be 2006, discussion with Rectors who said, ‘this is a nice idea, just go ahead’ ...”.

UTA and TUT have relatively different cultures. UTA is more focused on basic research (Sotaraute & Mustikkamäki, 2015, p.349) while TUT has both applied and discovery focus. So, it was a big challenge to bring researchers from both the universities closer to work on the interdisciplinary field of regenerative medicine. One group head pointed out this issue in following words:

“before Hannu[2011] we had, may be a year ago before Hannu came, ...may be about seven or eight professors from both the side[UTA and TUT] here in Tampere and we sit there in meeting rooms and there were both Rectors from both the sides and then expressed that we have now this kind of nice ideas; then they said, ‘ok, this is good idea, just carry on and we will support it’. But

practically nothing happened, so inside the university there was some kind of really momentum very slow.nothing happened even we pushed hard. So, there was of course Rectors said it's okay. But then it was kind ofI don't know why it stopped..... the main challenge really has been to get this kind of bigger changes to university; not really Rectors but through university administration; so that has been really very slow”.

Another key actor confirmed the difficulty in establishing collaboration between the two university, “collaboration between TUT and UTA has always been very difficult”.

Clark (1986, p.234) has indicated that universities are “bottom heavy”, meaning authority is diffused and capacity for collective action is very low . Consequently, implementing a change in universities is very difficult and complex process. So, the third hurdle identified above is in line with Clark’s observation.

In sum, lack of support from the university in the form of low basic funding, absence of tenure for the young research group heads, and sluggish response from the university administration to keep pace with the growing demands of the new research field were important cultural conditions which could have influenced the growth of the new research field.

5.1.4 Conflicting expectations on Researchers

It is important to see that researchers in regenerative medicine research, which is an applied field, faced conflicting expectations from the University and from the funding agencies on whose support they have been dependent on. Universities have been focused on high impact publications to improve their ranking while many funding agencies have started to expect innovative products as the outcome of their funded research. For example, TEKES started its Strategic Research Program in 2010. It was not easy to simultaneously meet both the demands, especially if the researchers are not tenured, because they cannot ignore university’s expectations. It was also difficult to publish in high impact journals if the research area was of applied nature or when the impact factor of the journals of the new field is low. Ylikomi described these conflicting expectations in following words:

“What I have all the time complained here is that the University head and Ministries and locals, it means hospitals etc., all say that we should serve the society, also doing products, even money and we are here to help people and treatments and that is important. But then if somebody does it, because if he does more applied science, it is possible, but it is very rare that you can do very high impact science in the applied area. You have to be very smart or you have to be in a very special area. I have not been able to make very high impact papers and applied wide. So, the problem is that, for instance, if we get grant from TEKES, we had many grants from TEKES in 2000 and so on or in last fifteen years, TEKES wants that there must be some product or patent or some innovation which will be taken forward to the commercialization. So, if we have a patent and if we have a prototype then TEKES is happy. If we present that to the University to whom the TEKES gave the money; they [the University] say that's not good.....(Ylikomi gave a strong gesture of rejection).... because you [have not published]; you should not delay publications because of the patents, especially before they were very much thinking of that we should do just the

science [discovery or basic research]. So that if we got the money from TEKES; TEKES is happy if we have prototype and patents, [but] the university is not very happy because there are not very high impact factor papers.

A researcher who was not tenured could not afford to annoy authorities at the University, as Ylikomi has expressed:

If I want to renew my position, it does not help if TEKES is happy if the University heads are not happy on my publishing; because they would say “Ylikomi is doing nonsense” [Ylikomi gave another strong gesture of rejection]. So, there has been, and still there is a kind of discrepancy between the what is spoken and what the state and the Ministry expect from the researchers and what does the Universities expect”.

Talking about the expectations, one group leader said:

“high level publications and then also it was expected that we will make products. Some kind of new treatments or products for cell culturing purposes, for instance. Not just treatments, but products [however], in the School of Medicine, I think commercialization wasn’t highlighted that much as it was in Regea. But in Regea, I think that the weight was more in science; we had to do good science. But then if possible then you should develop treatments”.

This was even more challenging for the young researchers. One group head highlighted it these words:

“If you don’t publish, I think, you don’t get funding for your research and of course all the group leaders who started in 2004/5 were young researchers. So, they had to kind of build their scientific careers and scientific careers are based on publications”.

One researcher from TUT summed up the contradiction between the expectations of the University, the funding agencies, and their research center which implement the projects (BMT in this case) in these words:

“In our TEKES funded projects there has been a strong aim to produce results which can be commercialized. This aim has been even stronger than the aim to generate publications. University has valued these aims differently than TEKES as a funding agency and BioMediTech as an institution which implements the projects. This contradiction in goals can be seen for example how the university evaluates the outcome of PIs' work. The effort used for increasing the business and commercialization value of the research results has not been appreciated in the university's internal evaluation as much as other efforts”.

Talking about the above contradiction in the goals, one group head made comment like:

“There was not a clear vision how to proceed with the products and business development”.

One group head noted a conflict between commercialization and basic research. She also noted this conflict was less during the time of Regea. Although Regea had motto of “*from research to clinical care*”, it was still focused on high impact publications the young researchers had to meet the expectations of the University and also it was important for them to write high impact publications for their scholarly career. However, when BMT was established “*expectations... were changed a bit, yes*”, she noted.

5.1.5 Establishing Collaboration between UTA and TUT

Regenerative medicine is an interdisciplinary field of research. It was, therefore, essential to bring the researchers from various fields of engineering and medical to work together. That is collaboration between UTA and TUT was a prerequisite to establish the new field. However, the two universities had relatively different cultures and were working in silos. For academics in UTA research excellence was top priority. On the other hand, for the faculty in TUT, innovation and commercialization was the most important thing. (Sotarauta & Mustikkamäki, 2015, p.349). Confirming this situation, various interviewees noted that culturally the two universities are different, their decision-making systems are different, their fields of science are different, and people working there are also very different. UTA has always been an academic university, focused on teaching. During the last twenty years or so, it has extended its focus to research excellence. TUT, on the other hand, has been for a long time very practice and industry-oriented university because it was established as such. It was established as university for industry. As a result, the faculty in the two universities had different mind-set and different priorities. The faculty at TUT has been more practice oriented, focusing on innovation and commercialization and less emphasis on publications. Most of the faculty in UTA has been focused on scientific excellence and high impact publications, while innovation, commercialization, and collaboration with the industry was not their priority. Furthermore, there had been proposals from Ministry of Education in 1990s that TUT should be merged into UTA as one of its Faculties. Such proposals created various kind of problems and exacerbated the rivalry between the two universities. Another key actor confirmed the difficulty in establishing collaboration between the two university, “*collaboration between TUT and UTA has always been very difficult*”. Another interviewee described this issue in following words:

It was not easy to establish BioMediTech between the two universities (UTA and TUT). It was horribly difficult because there has been strong rivalry between the two universities for decades.

One group head pointed out this issue in following words:

“before Hannu[2011] we had, may be a year ago before Hannu came, ...may be about seven or eight professors from both the side[UTA and TUT] here in Tampere and we sat there in meeting rooms and there were both Rectors from both the sides and then expressed that we have now this kind of nice ideas; then they said, ‘ok, this is good idea, just carry on and we will support it’. But practically nothing happened. So, inside the university there was some kind of really momentum very slow.nothing happened even we pushed hard. So, there was, of course, Rectors said it’s okay. But then it was kind ofI don’t know why it stopped..... the main challenge really has been to get this kind of bigger changes to university; not really Rectors but through university administration; so that has been really very slow”.

The universities are “bottom heavy” and are very slow in adopting changes, as has been discussed in the section 5.1.3. So the delay in establishing a collaboration between the two universities could be partly explained by the intertie in the universities’ administration. However, other reasons, including different cultures, distinct way of doing things, different mind-sets, and an inward looking strategy were inhibiting fruitful collaboration. Consequently, the universities had been working in silos. Overcoming these barriers was prerequisite for establishing any kind of multidisciplinary collaboration between the two universities.

In sum, researcher engaged in the applied field of regenerative medicine were facing conflicting expectations from funding agencies and from the University. Furthermore, low institutional support, slow response from universities administration, and different cultures of the two universities were the main barriers in the institutionalization of regenerative medicine research filed in Tampere. All the above mentioned socio-cultural structures could have constraining effect, nevertheless, there were many enabling conditions also.

5.2 Field Level Enabling Conditions

It is important to see the factors which worked as enabling conditions for the actors. Actors could capitalize on those enabling conditions to promote their research ideas. Some of these enablers were of institutional nature, while others were, “*luck and coincidences*”, as Ylikomi called them and shared some of those. First those enabling conditions are explained here which fall in the category of “chances”.

5.2.1 Enabling Regulations

On April 07, 2004, European Union promulgated a new regulation titled “*Safe human tissues & cells for transplantation*”. Similarly, in July 2007, Finnish government enacted National Tissue Act. The new regulations laid down the quality and safety standards for transplanting the human tissues and cells to prevent the risks of infection and transmission of diseases. If the tissue is exposed to the environment at any stage before the transplantation, it must be handled in a clean room (an area where particle counts and the microbiological conditions have been according to a set level). Thus, the regulations had strong implication for the operations of the tissue banks in the Finland and other EU countries (Regea, 2008a). In Finland, tissue banks were historically operated by the hospitals. But due the changing regulatory requirement for the operations and quality of tissue banks, Pirkanmaa Hospital District which owns and runs Tampere University Hospital decided to outsource its tissue banking facility to the newly established Regea Institute of Regenerative Medicine and gave funding to Regea for establishing clean room facility which complied Good Manufacturing Practices (GMP) specifications set in the abovementioned two tissue acts (Sotarauta & Mustikkamäki, 2015, p.351).

Due to EU directive, many European research institutes and universities started to build clean room facilities. For instance, Karolinska Institute in Stockholm built its clean room facility in 2004/5. Also in UK, there were some universities which built their clean room facilities during the same time. Ylikomi noted that “*in the late 2000, so many places started to have clean room facility*”. The Steering Group in Tampere was also successful in getting funding for the clean room facility from BioneXt (BioneXt, 2010, p.2). So, the new regulations helped the emerging field of regenerative medicines to get the required basic infrastructure.

As regulation was gradually evolving, it provided a conducive environment for the growth of regenerative medicine research in Tampere. Researchers at Regea started stem cell therapies in 2006 when there was no regulation for the manufacturing process. At that time, there was a regulation only for getting consent from the donor for the treatment. In November 2007, EU passed another Regulation (EC) No 1394/2007 on Advanced Therapy Medicinal Products(ATMP) amending its earlier directives of 2001 and 2004 approving certain therapies for individual patients. Finland adopted this regulation in 2009. The new regulation also had hospital exemption rule. This rule allowed the use of new therapies for experimental treatments, however, only for named individual patients without passing through clinical trials which are required for normal drug development. All the surgeries conducted by the doctors in Tampere Hospital were conducted under hospital exemption rule. In order to perform these surgeries, professors of UTA and TUT negotiated with the doctors at the hospital. The doctors talked to their patients who had no other treatment option. It was also necessary that a patient allow the surgeons to perform an experimental treatment. Patients who had no other treatment options gave consent to the doctors for conducting their experimental treatment. So, when all the three actors (professor, doctor, and patient) agreed to perform the surgery, they could go ahead. But it is important to note that contrary to US, if doctors in Finland fail in the experimental treatments, they are not held liable for any loss to the patients. It is always the hospital which bear the liability. So, the Finnish health care system enabled the doctors to take risks and see the results of the new treatments developed by stem cell researchers. The negotiation amongst doctors, patients and professor was always bottom-up process because the negotiations were always done at the lowest possible level.

As the regulation evolved, researchers at Regea adjusted their processes and their quality system to conform to the new regulations. Paula Salmikangas who was working in Finnish Medicine Agency (FIMEA) played a key role in the adoption of new regulations in Finland. Before joining FIMEA, she had worked in European Medicine Agency(EMA).

5.2.2 Changing Culture of Universities

Earlier for many professors at TUT, it was important to develop something useful for industry. It was considered their core competency to work for the industry. While scientific publications were not their priority. On the other hand, for researchers at UTA, scientific excellence was the most important thing. Applied research, innovation, commercialization, and working with industry were not their priority. However, one interviewee noted that the culture within the two universities of Tampere has been changing lately. The new professors in TUT are different, focusing on innovation and commercialization, on the one hand, and on research excellence and publications, on the other hand. This shift in their orientation towards scientific excellence has been caused partly due to the new funding system of the universities that favors the journal articles. Moreover, the new generation of academics want to simultaneously perform scientific research and collaboration with industries. Similarly, the culture in UTA has also been changing because in 2004 Finnish universities act was amended and interaction with society for promotion of scientific and cultural activity became part of the universities mission (the so called 3rd mission) alongside teaching and research. As a result, the academics has started realizing the need to collaborate with industry and society.

So, the changes in the broader context has brought cultural changes in the two universities. Although very slow, a shared understanding and shared logics of action have been developing amongst the two

universities. As a result, the tension between the two universities has been fading away and the new vistas of collaborations have been identified. The two universities will be merged by 2019.

5.2.3 Emergence of Triple Helix

In early 2000, the lobbying work of Ylikomi and his colleagues had started to bring the fruit. Many influential quarters (all the three universities in Tampere, Tampere Hospital District, City Government of Tampere etc.) had started supporting the idea. One key actor confirmed that the, *“University Hospital had big role in this.... when Regea started, they financed a small amount of investments”*. The support at UTA for regenerative medicine research was evident from the decision of appointing Riitta Seppänen-Kajansinkko by the university board. According to one key actor: *“Board had to interview Riitta Seppänen-Kajansinkko and everyone thought that she was the right person, and believed on that idea”*. People in administration also started believing in the new ideas due to the efforts of many actors including Timo Ylikomi and Pertti Törmälä. Timo Lahti who supported the new ideas said, *“I don’t have so much to say on this; I am not scientist. I have to believe in what they were doing”*. The Rectors of University of Tampere had also been supporting the idea. As at this stage, Triple Helix of academia-government and R & D organizations (excluding businesses) was already established as Professor Markku Sotarauta, one of the member of the Regea’s Executive Board, put it:

“But in the second phase, the leading person were not so much perhaps from the universities, but from ... like local and regional development agencies. Academics were involved, but it was a small group of people who thought this [cell and tissue engineering] is important and we have to have it[cell and tissue engineering] here.[Important people were] from the university hospital, from the scientific community and R & D. It was not specific academic researchers, but group of people combining, kind of triple helix combination, but not businesses. But public sector, hospital, R & D organizations, universities, and local development agencies”.

It is important to note here that the first helix in this case was were universities. Second helix was government organizations, for instance City of government of Tampere, and Employment and Economic Development Center. While the 3rd helix was civil society organizations, such as Tampere Hospitals and Coxa.

Regenerative medicine was an applied field of research; commercialization was logical outcome of it. Thus, establishment of BMT was an enabling condition for the researchers of regenerative medicine because it not only improved operational conditions, for instance, more basic funding, support for project management, intellectual property, patent, communication, business development, and tenure for some group leaders, but also changed the focus of research from discovery to commercialization. BMT also helped break the silos and provided a place where researchers from TUT and UTA could work on joint research projects under one roof.

Once BMT was established, Hannu Hanhijärvi was acting like an agent of Triple Helix. So henceforth, Triple Helix was an external enabling condition. One can see that Hanhijärvi's main task was to promote university-university-R & D organizations-government-hospital linkage for commercialization purpose. He selected only those groups from both the universities which had

commercialization potential and could have impact on regional and national economy. At this stage, he was working as an agent on behalf of his principles (two universities of Tampere, Hospital, and City Government of Tampere etc). In other words, Triple Helix of University-Government-R&D was an important enabling factor from 2003 and onwards. The role of triple helix gain prominence when Hanhijärvi started to lead BMT.

5.2.4 Role of Local Organizations

Goddard et al. (2013, p.13) have underscored the role of intermediary partnership organizations in establishing collaborations between universities and the civil society where the universities are located in. They argue that *“these organizations normally have only very limited resources themselves, their style of leadership must necessarily be facilitative and understated, concentrating on mobilizing and aligning key public and private organizations within their city to achieve their goals”*. Some organizations in Tampere, such as FinMedi Oy, developed an enabling environment for the new research area. Mission of FinMedi Oy was to develop businesses in the area of life sciences in Finland (FinnMedi, 2018). Similarly, programs started by regional governments, such as BioneXt, also supported the fledgling research area in Tampere. BioneXt was a small program from 2003 to 2010 for promoting biomedical engineering in Tampere Region(BioneXt, 2010). It was started by City of Tampere. Jari Hyttinen and his colleagues got some seed funding of 50,000 Euros from BioneXt to buy an electrophysiological instrument for carrying out some experiments. This seed money helped them to apply for another funding of 912,000 Euros for regenerative medicine from Academy of Finland which they got in 2008. This funding was the beginning of a new cycle of funding. According to Hyttinen, *“we were able to quite quickly establish some other smaller funding around the Academy of Finland project”*. Furthermore, Academy of Finland’s initial funding supported eight research groups, four from TUT and four from UTA. This project brought these research groups together and strengthened their collaboration. According to Hyttinen,

“of course, we saw that we should work together but if we didn’t have that one project[funded by Academy of Finland] then the collaboration would be much more difficult”.

5.2.5 Changing World View

While funding from Academy of Finland paved the way for regenerative medicine research in Tampere, the funding decision of Academy of Finland might have been affected by the world view about stem cell research at that time because there were many expectations from stem cell research in the world in general. According to Jari Hyttinen:

“I think that was the time when there was reallylets say....larger view in the world that there is really something and this[regenerative medicines] is really emerging ...this is very very important field of topic as well”.

5.2.6 Group Culture

Cohesion and culture of the eight research groups working on regenerative medicine also provided an enabling environment for the new research filed. The research groups working on regenerative medicine were comprised of talented researchers, had strong cohesion, and they always supported

each other. These factors build their reputation and helped flourish the research field. According to Hyttinen:

“I think it is important that people who are there ... have a similar kind of ideas and support each other....inside Finland we were still quite well funded, or lets say not ...relatively well funded and we had major group worked together and gathered expertise around it; I am quite sure they[funding agencies] saw us well that it even they[researchers of UTA working on regenerative medicine] have no tenured [professors], it was quite nice environment for them to make their research....”

Comparing the support they got from their universities with the support they received from other groups working on regenerative medicine he said:

“I think it was not university level but this kind of inside this group of, we had eight research groups together working already back then and inside this, I think, everybody saw that if we do things nicely, we can achieve a lot of things”.

During the challenging phase, it was not only the researchers' own commitment, but also the support of the other groups which helped every one.

“I think it was my own commitment, but also these other people's commitment. So, I think that kind of feeling of having same kind of vision helped all of us. I think overall it was the more or less the team spirit on this Regenerative Medicines area. ...that really helped us and I think that partially enabled us to reach certain science outputs and also other outputs quite early already”, said Hyttinen.

Showing her satisfaction on support she got from her group, one group head commented like, “you are not alone, you get support if you wanted to do that.....environment in Regea was supportive”. All the group heads were taking care of each other. One group head explained the group culture in these words:

“Those other group leaders that I mention that came at the same time with me to Regea, we had very good collaboration with them and really we supported each other. So, it was very encouraging environment even though we didn't get that much support from the University”.

Senior group members, group heads and the Principle Investigators have been nurturing a safe and sustainable environment for the junior researchers. One group heads shared his approach in these words:

“I think that the mentality here in our research groups in this area that we PIs are kind of trying to solve this kind of funding issues and of course even though our researchers are applying funding too, ...they don't know everything, we are trying to ...keep them safe from this kind of thinking that do we get enough project funding for the rest of our..... so we ...keep them safe from this kind of things. So they don't know...pressure probably”.

Another group member acknowledged that “*probably people around me [were important supporting factor]. I have a nice group. That is very important; nice society, nice group*”. She “*always discuss problems with other PIs, especially ... funding issue*”. These are the main topics which they regularly discuss. Similarly, for other group heads, “*good working environment and collaborators*” and “*very good and fruitful cooperation with other research groups of TUT and BioMediTech*” were important enabling factors which, besides their personal level factors, had been supporting them to pursue a career in cell & tissue engineering.

5.2.7 Role of Finnish Funding Agencies

At the same time, two important Finnish funding agencies, TEKES and Academy of Finland, announced their new funding policy of Strategic Research Program and Profile Funding respectively. In the new policy, they shifted their focus from discovery and to strategic research. Because of the changed policy, researchers had to identify the benefit of their research. According to Hanhijärvi,

“every researcher has to tell, what is the story behind your research? Why do you do this? Is there any future potential benefit of it, or you are just doing for fun. So, you have to tell and it was a tough cookie for many. But now they have the motivational thing. That every guy has an opportunity to think also the other way. It has stimulated this whole thinking very much. And people like it. So the word Strategic Research has replaced translation and discovery; everybody is strategic researcher now”.

As has been noted in section 5.1.4, the new funding scheme by TEKES and Academy of Finland also created a conflict of expectations from the universities and from the funding agencies. The funding agencies expected applied nature of research which could be immediately translated to innovation and commercialization while the universities were still expecting high impact publications.

In sum, new regulation at EU level as well as at the country level, emergence of triple helix of public sector-universities-R&D organizations, favorable role of funding agencies, internal group cohesion and conducive culture, establishment of BMT under the vibrant leadership of Hannu Hanhijärvi, shift in the culture of the two universities in Tampere, and the role of regional organizations were important enabling conditions in the second and third phases of institutionalization of regenerative medicine research field in Tampere. Establishment of Regea Institute of Regenerative Medicine can be marked as the beginning of the second phase. It is explained in the next section that how various actors made choices, how they overcome the institutional constraints, capitalized on enabling conditions and pursued their aspirations.

5.3 Human Agency

Although the constraints mentioned in section 5.1 and the enabling conditions mentioned in section 5.2 had their causal powers and could affect the institutionalization of the new research field, researchers were not mere at the mercy of these contextual conditions. They were able to make their own choices and through their motivation, passion, commitment, projective imaginations, and internal conversations. Consequently, they were able to establish a new field of research which would have not possible in the existing culture of UTA. Thus, in order to study the instances of human agency, motivations, hopes, fears, desires for the future, confidence about envisioned future,

and internal conversations, especially autonomous reflexivity, of various actors are described in the following paragraphs.

5.3.1 Motivation of Various Actors

Passion and curiosity about new research ideas, societal commitments, novel medical treatments, and commercialization were the main motivation of various researchers engaged in the regenerative medicine research field in Tampere at different phases.

Regenerative Medicine as Passion

Some academics played their role mainly due to their passion and curiosity about the emerging field of regenerative medicine. For instance, Timo Ylikomi played his role mainly due to his passion about regenerative medicine. Oxford Online dictionary has defined passion as:

“an intense desire or enthusiasm for something”

In the following discussion, it is evident that while promoting the new field of regenerative medicine and many other things, Ylikomi's actions were not “rational”, meaning he was not trying to maximize resources, time, efficiency, or productivity for his personal gains. Rather his actions were “guided by an emotional commitment or even a political sense of self”.

In 1993, Timo Ylikomi read a classic article titled “*Tissue Engineering*” in Science Magazine. Tissue Engineering was an emerging interdisciplinary field having the potential to cure many human health care related problems including loss or failure of human organ or tissue which were very common and costly problems. This new field drew from principles of biology and engineering for developing “functional substitutes for damaged tissue”. Realizing the importance of this new area, Ylikomi had a very passionate reaction when he read the article:

“wow, that's fantastic [he snapped his fingers forcefully when expressed his views]”, said Ylikomi.

Henceforth, he explored and realized different innovative ideas. In April 2001, he read another classic article titled, “*Multilineage cells from human adipose tissue: implications for cell-based therapies*” published in the journal, “Tissue Engineering”. The article had identified human adipose tissue (body fat) as an alternate source of autologous adult stem cells which could be used for cell-based therapies, such as tissue engineering. He got very enthusiastic about this sub-area of tissue engineering also. Recalling his reaction, he said,

“I thought that is mine, that is mine. I would like to go with it” (again, he snapped his fingers forcefully when expressed his views; his face was also glowing with the happiness).

But Ylikomi was not alone who was interested in the new ideas. Professor Susanna Miettinen, a research group head, joined regenerative medicine research area, or more precisely stem cell research area, as a post-doc researcher. She had done her PhD in Cancer research. However, she

started her post-doctorate work in stem cell research area in a project for which Ylikomi had got funding from TEKES. So, she started working in the new area because the project funding was for stem cell research. But explaining the reason and motivation to join regenerative medicine research field, Miettinen said, *“the project funding was for stem cell research and of course I was interested into that area too”*. Furthermore, she saw a direct link between her research and its actual application. It was a fascinating experience for her. She explained it in the following words:

“from 2004-07, there were so high hopes.....that stem cell would treat all the diseases and all the traumas in the world. So, everybody expected that they are now big solution for thing..... stem cell were something new. It was amazing that you can ... have a cell that can differentiate into other kind of cell type and then, of course, it was ...so close to this kind of real treatmentsyou could see the link between your research and then patient treatment immediately. We started doing our research in 2004, and we treated first patient in 2006 based on our [research]. So, there was a direct link between the research and the patient treatment and that was very fascinating”.

Talking about the new field of regenerative medicine, Miettinen said:

“Something novel pops up every day since the field is developing fast”.

In sum, for Ylikomi and Miettinen, it was very fascinating to work in an area where they could explore new things and could solve real life problems.

Regenerative Medicine as Societal Commitment

Some of researchers who started to work in regenerative medicine had strong societal commitments. For instance, Ylikomi was also committed to certain principles in his profession. Many academics focus on teaching and discovery research, the so called 1st and 2nd mission of the universities. But Ylikomi was also committed to certain ideals which are now called “third mission” of universities. Third mission mean universities should play active role in solving the societal problems. Telling about his professional commitments, he said,

“for me it’s very difficult...to motivate myself if I would do just the publications and [supervising]the PhDs. So, I would like to see that what I am doing leads to something; some application; whether it is product or service or certain way of treatment and that I could really see that this particular solution is now used with patients, for instance, so that taking something from research to applications”.

Ylikomi wanted to develop treatments using adipose stem cell,

“...having these stem cells, I wanted to make bone; I wanted to make something that I could heal bone”, said Ylikomi.

Ylikomi's ideals of higher education were made part of universities mission by the Finnish government in 2004 when Finnish Universities Act was amended and interaction with society for promotion of scientific and cultural activity became part of their mission(the so called 3rd mission) alongside teaching and research (Santiago et al., 2008, p.359). The amendment became effective from August 2005. Showing his satisfaction with this change he said,

"From the late 90's, I have promoted the idea that universities should also serve the society in a way that the society can benefit also economically...[now]we have to teach, research, and the 3rd is this to help the society; whether it's services, whether it's information.....or commercializing things. But it came much later than I started".

Similarly, for Miettinen contribution towards society was important.

"I find research still fascinating and I have a feeling that I am doing something meaningful", said Miettinen.

Another researcher said that she had been working in regenerative research field because her interest had direct impact on society, as she put it:

"The very fruitful collaboration with TUT groups and also with clinicians of TAYS[Tampere University Hospital], clinician really value our work! I am not person doing basic research, I do want to have clear goal towards helping society no matter how small my impact would be. Science for reason, to answer important questions, to have an impact".

It is obvious that the three academics discussed above joined the new research field mainly due to their passion and curiosity about the new field. In addition, the new research field had great potential to solve societal problems. They didn't perform any cost-benefit analysis or risk assessment before entering the new research field for which there was little support from the University.

Risks

Going against the institutional culture, or having ambitions which don't match with organizational mission may not be risk free. In order to pursue their passion, commitment, and future projects, researchers did take risks. For instance, Ylikomi has not been very well paid. He is still not a tenured professor. The shortest employment contract which he ever got from his university was of six months and the longest is of two years, which he currently has. However, despite his short term employment contract, he spent a lot of his time in promoting his innovative ideas. The opportunity cost for the success of innovative ideas was the time taken away from research and publications. As a non-tenured faculty member, there was a great risk involved in his lobbying activity because it was not only affecting his publications but also his reputation as his colleagues and all superiors were not appreciating his activities. Ylikomi was mindful of these risks and he acknowledged these risks in following words:

"I have an idea that even in the medical faculty there have been people who also during course of the process that they have not appreciated that I have wasted

my time in this kind of activity[lobbying for his innovative projects] and not making high impact publications.....some people wanted to take me down from.....I could have lost my position”.

Explaining another possible reason of his risk taking attitude, Ylikomi said,

“this failure [in the research project in France] is one important factor that made me to change my field – made me to invent a plan B. Without the failing, I might have continued the hormone research and not invest my time on cell and tissue engineering”.

By plan B, it seems that Ylikomi was choosing the new research area by carefully making cost-benefit analysis, i.e., a “rational choice”. However, he rejected the idea that by choosing Plan B he was trying to achieve some instrumental goals.

“No, No, I don’t know; because again failing somewhere and then jumping to very new [area] ... which I don’t know whether it succeeds...it is not really rescuing my credibility, because I could also fail there; so, more logical would be that I fail here then I would do something very steady things”, commented Ylikomi.

So, instead of doing steady research in the same area, he started experimenting other research areas. His subsequent actions corroborated his claim that choosing a new research area was not for instrumental gains. There were some gossiping about Ylikomi’s innovative activities in the medical faculty,

“.... ‘why Ylikomi is wasting his time in this kind of activity. He should do more publications, better publications, he should direct more PhDs’..... This was a risk. But, I rather do things which I like its important than just thinking about my chair”, said Ylikomi.

Pointing out some other risks of his endeavors, he said:

“I am not very much paid...[but] I don’t pay much attention as long as I could play some role. It just does not very much hurt me because I ...so that if something happens then I would do something else”.

However, after all the above efforts and risks, Ylikomi when reached to a stage where he was offered to lead the newly established Regea Institute of Regenerative Medicine, he turned down the offer. Recalling the those moments he said,

“I still remember very vividly the moment when I was offered a position of the head of Regea and I refused. I decided that I will not be a head of Regea and FICAM. That was giving up – and it was somehow painful. I realized I could not invest 100 % of my time on one of these parts, the giving up hurt”.

Explaining the reason of giving up, he said,

“Free spirit, retain the freedom of being fascinated & inspired of something new and not bound to something that takes 100 % of my time..... I don’t know, I always wanted to do something new. Is there some more deep personal psychological aspect. I have thought a lot about my character that I rather guide things from the back, rather than act in the front”.

These comments show that Ylikomi was mainly interested in the emerging field of regenerative medicine because of his innovative nature; he kept pursuing the idea and promoted it in Tampere. But he abandoned pursuing it when he realized that it will take all of his time and will not let him to pursue any new thing. He didn’t take the managerial position to stay as a “free man”. Professor Hanna Tähti, one of his colleague, acknowledging Ylikomi’s contributions for the establishment of regenerative medicine research field in Tampere, corroborated his nature in these words:

“Timo is such kind of researcher who gets always new ideas and then he go little ...for a short time he is interested in it. Then he goes to another idea....and he is not such kind of person who sits and studies one question or problem very long time. He gets always new ideas.....he is very good colleague in that meaning”.

The above description clearly shows that Ylikomi’s actions were not based on cost-benefit analysis. Even his Plan B was not a “rational choice”. He was passionate to learn a new thing. Susanna Miettinen also expressed the similar approach in the face of resistance and lack of organizational support. Talking about the possibility of risks in the new field, she commented:

“Emmm.....perhaps it wasn’t a risk, but I didn’t think it that way.....(she laughed loudly).....I was young and enthusiastic.(again, she laughed loudly).....So, I didn’t think about the risk that much”.

In Miettinen’s case, it was her interest and passion which helped her to circumvent the institutional constraints.

“I think it was my interest. It is always the research interest that is kind of driving force. We were all interested in our own research area and we were committed too, ...that’s the correct word”, said Miettinen.

In sum, while some academics played key role due to their passion and societal commitment, Ylikomi had other reasons to indulge into the new research field of regenerative medicine. These reason can also be described as a broad dimension of his societal commitments. For him discovery, innovation, and commercialization of research were part of a bigger whole: societal commitment.

Regenerative Medicine for Sustainability

Ylikomi envisioned various projects including developing tissue models for studying toxic effects of different chemicals and working on stem cell[regenerative medicine] for developing bone, as he put it:

“I definitely wanted to make these tissue models to study toxicity, to study the drug effects; I wanted to have this kind of models that could be used, for instance, for [knowing] the safety of different chemicals. Then having these stem cells, I wanted to make bone; I wanted to make something that I could heal bone; but on the others ...this was the research side”.

With his diverse projects, Ylikomi was also trying to develop a sustainable ecosystem of teaching, research, and commercialization in various areas. He was of the view that if there is only one project, it could end soon end. Therefore, it was necessary to pursue projects in various areas. To achieve his goal, first he along with Hanna Tähti established Cell Research Center (CRC), then he lobbied to establish clean room facility, which was part of the required infrastructure, and for commercializing certain research ideas, he established an entrepreneurial venture called ChipMan. His envision projects have already been illustrated in Figure 4.3, which he summed up in the following words:

“on administrative side, I really wanted to create the cell and tissue engineering unit or activity here. So that having in a center that would do research work here with the varying disciplines so that the Hospital, Medical Faculty, VTT, and the Technical University [could be involved]. Then having these infrastructural units, so that having this Cell Research Centre (CRC) for building these models and having this Tissue Engineering Unit to having the Clean Room Facility. I was also promoting the Tissue Banking at that time. It does not take that time so I was participating in certain international conferences to be able to establish here the Tissue Bank, both for research and also to get human tissue easier from the hospital to the research. I tried, but now it started very well in 2010, 2012, but in the beginning of 2000 it didn't start, but I tried that”.

“So we have this infrastructure and then we had this company called ChipMan, so that Research, Infrastructure and then Commercial Application and Tissue Engineering Centre and then like university hospital using those and also aiming to create as real treatment for patients. So that it could be done. Because if you only have one project, so it dies very easily. So if you get a only Academy of Finland or TEKES funding, it just vanishes. But to anchor something here[you need more]”.

At broader level, he was trying to develop a research and commercialization niche for Tampere, as he put it:

“I saw at that time that this kind of activity is not very much done...anywhere else in Finland at this extent. So, I wanted to make this kind of Tampere flavor. So, Tampere area. So that it would be focusing on cell and tissue engineering[regenerative medicine]; so we [could] have research, we [could] have this infrastructural facilities and also that we would start to do some commercial activity”.

While some of researchers discussed above played key role due to their passion and societal commitments, some actors played role due to other motivations or due to their social positions.

Regenerative Medicine as Novel Treatment Option and Commercialization

Professor Riitta Seppänen-Kaijansinkko joined UTA in 2003 to lead the emerging regenerative medicine research group. She is an experienced Oral and Maxillofacial surgeon. She saw that some defects, for example, trauma defects or defects which may be caused by the removal of tumor in one's face, could not be fixed by traditional medicinal or surgical means. So, she saw that stem cell could be the solution. Through stem cell new bone could be created to replace the bone that had been removed for whatever reasons. Accordingly, she saw a medical need for the new research area and for application of this research. For her, the new research area was important from professional point of view. It could provide solutions for some of the unsolved problems in her professional area.

Similarly, for Professor Pertti Törmälä, working with industry on applied research areas for commercialization was more important. Talking about his priorities, he said:

“I had always that principle that I work with the industry, they give money for us. With this money, we can do diploma works, we can do license works, we can finance doctoral thesis, and results are: the companies get first results to use. But in doctoral thesis, for example, the diploma works[the results of doctoral researches] ... come sooner or later public. So that is good also”.

For him patenting is one of the more fascinating thing than publications:

“at least in my own opinion, making patent applications is more exciting and interesting than writing scientific publications. In patent application your imagination fly”, said Törmälä.

In sum, Seppänen-Kaijansinkko and Törmälä became interested into the new research field of regenerative medicine due to their professional needs or commercial interests. In order to pursue his conceived project, Törmälä had proposed Seppänen-Kaijansinkko's name to lead the new research area. He was convinced that through her professional and personal skills, she can lead the new research area. Törmälä also utilized his entrepreneurial experience and his professional network to establish research collaboration between UTA and TUT, which was a must for the multidisciplinary field of regenerative medicine.

Hannu Hanhijärvi had come from industry (pharma and venture capitalists) and had entrepreneurial mind-set, therefore, he was interested not only in applied research but also to develop products. His motivation can be understood by his following statement which he gave to TEKES:

“we told that this is the issue where we say it's not only research, but we want to have product; we want to develop product. It is payback time now for the University. So, back to society something value. TEKES loved the idea. So, we asked Euros 10 million and they gave us 10 million (he laughed loudly when said this)”.

Finally, one research group head emphasized that they actually made a “rational choice” in entering the field of regenerative medicine:

“why you do it[research in regenerative medicine research area] because you see the great potential on that area and, of course, what I saw as well that what I have learned....my own expertise were those could be easily used in that area they were really needed as well. In Regenerative Medicine area. Or let’s put it this way that I saw myself and then I sold the idea (he laughed loudly when he said so) to the people working there.”.

This statement shows that they¹¹ entered into the new field after carefully evaluating their expertise, their relevance for the new area, and the growth potential of the new area. So, it was clearly a rational choice. For them, it was not only a good research collaboration opportunity, but also an opportunity to develop marketable products, as they put it:

“I think..., we thought it was very nice idea and we saw that we were really, at that time, really on forefront with our ideas kind of worldwide doing something nice. I think that was really important on that. I think it was my own commitment, but also these other people’s commitment.”.

So, it seems that they ranked their group’s performance in the regenerative medicine research area on a global level. A high perceived ranking gave them courage and support to enter into the new research area. They not only got support from their group members, but also it was each person’s own commitment to the new area. The commitment also came from high perceived ranking of their group’s work.

In sum, various actors had various motivation to enter in the emerging field of regenerative medicine research. These motivations included passion and curiosity, societal commitment, new solutions to old problems, commercialization of research ideas, and other rational choices. The risks involved in some of the above mentioned endeavors shows that the academics’ inspirations were not supported by the institutions, they were going counter current. These risky aspirations had either come from or were strengthened by their vision about future, their confidence into their capabilities, their passion, or social commitments.

5.3.2 Projective Imaginations

In spite of discouraging attitude by some of his colleagues, Ylikomi kept pursuing his ideals due to various reasons. First, he had vision of many things and based on his vision he gave innovative ideas to his colleagues, as one of his colleague, Hanna Tähti who is now professor emeritus, commented:

“I always remember that.....because we worked together...Timo and me....at the end of 1990 when we started Cell Research Center (CRC) and we were often sitting in the evening and thinking what could be the future and then Timo got a very good idea which is[was] not realized: Human-on-Chip. Actually, all human

¹¹ ‘They’ is used here to hide the gender of the interviewee.

cell can be cultivated and nowadays you can also find methods that all tissues of human body are on one chip and you can test different chemicals with them”.

Tähti’s testimony shows that Ylikomi was good in giving innovative ideas. Secondly, he was also convinced of the future potential of the new field of regenerative medicine. Tähti also confirmed Ylikomi’s conviction about this new area in following words:

“We can create tissues which are like normal tissues and then, of course, the start should be stem cells: human stem cells. That was, I guess, was the idea to develop human tissues and then later, for instance, Timo got the idea to use those tissues in practice; for instance, those to cureyou know ...if they get some injuries in the legs you can put new tissues.I don’t remember the word....[here, the interviewer helped her to recall the word by saying Cartilage? and she said, “yes”]. A kind of practical use also of this tissues”.

Telling about his conviction Ylikomi said, *“I could really see that this particular solution[will be] used with patients”*. Hanna Tähti further commented:

“So he sight[the need and significance of regenerative medicine], I guess, much earlier than many others in this university”.

Similarly, Jari Hyttinen and his colleagues from TUT were clear and confident about the potential of regenerative medicine. They had vision that it will ultimately be successful. *“I think we had the insight, not just me but we had a group here who had the vision that we should really have this joint institute and collaborate[to tape the potential benefits of regenerative medicine]”*, said Hyttinen.

Although Riitta Seppänen-Kajjansinkko and Hannu Hanhijärvi joined in the second and third phases of regenerative medicine research in Tampere, but confidence was also an important characteristic of both of them. Recalling his early days in BMT Hanhijärvi said, *“I had some confidence that something is going to come out. But I had never worked with stem cell, so...”*. Similarly, Seppänen-Kajjansinkko was also very confident and due to her confidence, in the beginning she was going very fast.

For Ylikomi, confidence about the outcome was more important than experience and competence in any field of research. *“competence comes from confidence”*, said Ylikomi. His confidence encouraged him to indulge into new areas. Explaining his views, he said,

“In science there are many[researchers] who think that one can achieve a competence only by being involved for a long time in one field. There are also scientists who think that it is suspicious to change one’s field. These people think I would have credibility only in the field of hormone research. In these lines many scientists think it would be a long process to change one’s field - one needs to gain high level of competence by doing studying, before entering a new field”.

This statement shows Ylikomi’s colleagues were refraining him from entering the new field of research. But he followed his own conviction due to various reasons. First, he was passionate about

the new field. Second, he wanted to contribute towards society and towards local economy. Third, he was confident about his success. Explaining the reason of his confidence he said:

“I did not have deep understanding/knowledge of the cell and tissue engineering [regenerative medicine] when I started to promote/lobby these fields. I went in some meetings, but it was something like that I had a confidence that since these techniques has worked somewhere else by someone else, we can get them working here in Tampere (he laughed loudly when expressed it)”.

Talking about the developing future leaders to promote innovation in universities Ylikomi said:

“It is important to cultivate thoughts that do not, at the present moment, represent totally the realism[reality]. To have a courage to lean on the invisible – lean on something that is not yet there, but what you believe is possible – just a vision but a strong vision”.

Finally, Ylikomi had autonomous reflexivity, explained in the next section.

5.3.3 Internal Conversation

In this case study, the instances of autonomous reflexivity of only one of interviewee, namely Ylikomi, has been explained because he was the only person who was promoting the new field of regenerative medicine without having any formal position. Ylikomi's assertions have also been corroborated by his colleague, Hanna Tähti. Although it was possible to find detailed account of the three features of autonomous reflexives, namely 'contextual discontinuity', 'unproblematic dovetailing of their concerns', and 'individualism', this researcher sufficed to the instances of autonomous thinking which are cited in the following paragraphs.

It is important to note that Ylikomi's *autonomous reflexivity* helped him pursue his passion, commitments and even to be ready for potential losses in pursuing his future projects. It is explained above that Ylikomi's colleagues proposed him to abstain from entering into the new field and some of them even opposed his endeavors due to various reasons, but he kept pursuing his ideals. He was very selective in discussing his ideas and was not trying to get approval of his colleagues about his activities. Talking about his autonomous thinking he said,

“In science there are many who think that one can achieve a competence only by being involved for a long time in one field. There are also scientists who think that it suspicious to change one's field. These people think I would have credibility only in the field of hormone research. In these lines many scientists think it would be a long process to change one's field - one needs to gain high level of competence by doing studying, before entering a new field”.

Ylikomi's course of action showed that he didn't agree with the above views. His autonomous reflexivity is also evident from his following reaction to his colleagues' advice:

“When proposing completely new ideas one has to be prepared to heavy criticism. People are usually unprepared for new ideas. There is a strong ground

for suppression and suspicion. People are also envious – ‘is this[taking something] away from me. Money will be spent for that, why not in my field and in my research’ ...”.

On many occasions he got discouraging response from his colleagues and superiors. But he didn't change his course of action due to criticism. Talking about his response to the criticism he said,

“[I] just ignored. I have my ideas, my views, and my ways. So, I proceed with that. I am influencing the people, lobbying people, those who really need to be influenced (he laughed loudly when he said so)”.

He described how his personality helped him in his autonomous reflexivity:

“Although not being very extrovert and also being shy and prone for being ashamed of my own properties, I was very resistant to the criticism. I have always said that, if I do not have arrows in my back [shot by the critics] I am not doing enough new and revolutionizing work”.

“I have a strong inborn character that I believe that things go well, and I am not being guided by doubts/self-doubts. Of course, there have been those mornings when I have woken up 3-5 o'clock in the morning and had those doubts ...”

Ylikomi did a lot of lobbying work for promoting his future projects, but instead of getting approval of his immediate colleagues, he focused on people who could provide material support for his projects. Talking about the kind of people he valued and tried to sought support for his projects, Ylikomi said:

“of course, with people whom I need to convince and to whom I need to lobby, yes. On the lobbying side, yes, I would do that for the people who can help me in making this thing happen, yes. But with normal colleagues here, not so much”.

One influential person in UTA who acknowledged Ylikomi's contribution towards regenerative medicine research field confirmed that Ylikomi regularly approached him to get his support. In spite of knowing the risk of pursuing his passion, he didn't try to get anyone's advice to deal with the criticism he was facing, instead he autonomously decided to continue his projects which were aimed to pursue his passion and societal commitments. He further commented, *“I rather do things which I like its important than thinking about my chair”.*

Hanna Tähti summed up Ylikomi's unrelenting response to criticism in the following words:

“I guess, [Timo]not always [got positive response]. But always it is so that Timo may give good ideas to others, but then other hear, cannot understand it, so, I guess, Timo is glad if he can give good ideas to others. He is just kind of a person”.

Contrary to Ylikomi, Professor Pertti Törmälä seemed communicative reflexives, the one who completes his *“internal conversation inter-subjectively or in the context of others”*. He seemed to

rely on his network and gave importance to team work. Törmälä has emphasized the need of team work in Science and innovation.

For Törmälä team work is prerequisite in promoting scientific ideas.

“The big view what I believe that development of science is not logical, it is always question of cooperation with people. Even if something should seem very valuable for future development, [however], if strong people don’t find it good for cooperation, don’t go forward”, said Törmälä.

Nonetheless, he might be autonomous reflexive in other areas of life.

5.3.4 Actors’ Past Work History

Greenwood and Suddaby (2006) drawing upon network theory have come up with the idea of “boundary bridging” to explain the institutional entrepreneurship by the organizations or actors who are at the center of an organizational cluster. They have argued that even core actors of an organizational cluster who have access or interaction with the actors outside their organizational cluster learn about new trends, ideas, and nascent opportunities. Furthermore, they can “transpose” those ideas to solve their pressing problems. So, the network position of the actors is important because it provides access to inter-cluster social spaces where new ideas emerge, consequently, the actors can envision and adopt a change (p.37-38).

Although not sufficient evidence could be collected about the early life movement from their initial involuntary placement, not only Ylikomi but three others actors in this study had worked or studied in a foreign country. Timo Ylikomi did his post doctorate in France. Jari Hyttinen, a research group head, did his Phd research in USA and Australia. Pertti Törmälä worked at Deutscher Kunststoff Institute in Darmstadtissa in Germany for one and half years from 1977-78. Hannu Hanhijärvi worked in different industries. He started his career from a University but then moved to pharmaceutical industry where he worked as head of R & D units for many years. He also worked for twelve years with venture capitalists. After retirement, he joined higher education sector in 2009-10. He had also work experience of not only Finnish market but also of international business in pharma and biotech.

However, the important thing is to see how their foreign experience helped them to bring or promote a divergent change. Talking about his foreign work experience Jari Hyttinen said:

“I also made visit to USA and Australia during my [PhD] thesis work. I actually spent almost one and half year abroad at that time and I would say what is important in those visit, you see how things are done, naturally the science, how the labs are running in various places; how you can do different things, but still run a lab and what are the good and bad ways for running the lab”.

This statement shows that through his foreign experience, Hyttinen could see weaknesses or contradictions, if any, in the Finnish way of working in scientific areas and helped him see the opportunities in pushing alternative ways. Talking about his previous experience, Hanhijärvi said,

“I was R & D vice president for ten to twelve years [in a company called Leiras Oy] and then we made the company international. So, we made the first product for international market. Then I ...learnt how to do international business in pharma and biotech. That was the one key thing”.

Hanhijärvi was successful in changing the focus of the researchers in regenerative medicine and BMT from discovery only to discovery and commercialization. As he had come from industry, commercialization of research was his main focus. Before Hanhijärvi, researchers were “*not that much*” focused on commercialization.

“of course, one thing that Hannu brought here much more stronger than what we had earlier that was the commercialization side”, because “he had been in industry”, said Jari Hyttinen.

With his entrepreneurial mind-set, Hanhijärvi could play important role in establishment of BMT, changing the focus of the researchers and deliver results. For him, it would have been difficult had he come from within University, as he put it:

“it was very important because I was not a professor coming from inside, so nobody could blame me that I was somebody’s side. You know universities are extremely sensitive on those things. But I was an outsider that Hannu has no whatsoever....so that somebody would be favored more than the other. No. They could not find one small thing that I would have favored somebody.

One of the researcher explained the reasons why Hannu Hanhijärvi who was an outsider was successful in persuading the University leadership for getting required support and overcoming the doubts. While the researchers working in regenerative medicine were ineffective in doing the same.

“I think that... the real reasons [was], of course, inside the universities, I think it is sometimes there are people who, of course, all the people would like to get more resources. I think that is clear; and we were fighting for the same resources. But when some outsider comes and say, look! these ... guys are good(he laughed loudly when he said this)... then it is much easier for the Rectors to decide....now this is the area to get going”, said one researcher.

So, Hanhijärvi’s contextual discontinuity (moving from industry to university) helped him to introduce divergent changes in BMT. As he had come from outside, he had no social network, therefore, it was possible for him not to succumb to anyone’s pressure or favor anyone due to his relation. So, his contextual discontinuity, coming from outside the university, helped him to promote commercialization.

Pertti Törmälä first time learnt about regenerative medicine field through his research collaboration with Tel Aviv University(Israel). Talking about his foreign work experience, he said,

“I think it was early 90s the first tissue engineering project we had in cooperation with Tel Aviv University(TAU). We developed the scaffolds for seating the chondrocytes and they[TAU] did animal studies with birds to create the new cartilage for knees. It was a small bird. That was the first time I think when tissue engineering was applied for making on new cartilage. It was scientific work which gave good results, but it never proceeded to practical applications at that time. But it had the influence that we established Regea in Tampere”.

“we have been working always with bones... in TUT, we were more bound with materials. I thought if we can have such an institution, like Regea, there we can have people more familiar with living cells, living tissues then become bind the material science and science of living cells and living tissues and to create new tissues”.

Törmälä, based on his previous work in biomaterials and his research work in TAU, was exposed to new technologies and nascent opportunities for solving problems of his own research and business filed. As a result, he envisioned *“that Tissue Engineering ... will be important in near future to create tissue, new cartilage, or new bone”*. His international linkage not only helped him to learn about a new field but also apply it in the work he was already doing using passive biomaterials. But it is important to see that in his foreign project he was involved in a different field of research, i.e., active materials and living cell contrary to his previous work experience where he was involved only in passive biomaterials. So, his foreign work experience helped him to broaden his vision and motivated him to capitalize on the new opportunity. Thus, his foreign experience translated into his agency.

Thus, it is very important to see that the actors who played important role in promoting regenerative medicine research, their past experience or more precisely their foreign work experience had important contribution in their effectiveness. Through their foreign experience, they were exposed to new trends and opportunities emerging not only in their own fields but also in the other fields. Their work experience in a foreign country helped them to learn new ideas or new ways of doing things and transpose those ideas for solving problems in the society or in their own fields. Thus, their foreign experience helped them to exercise their agency in overcoming the socio-cultural constraints.

5.3.5 Negotiation

This theme was identified during the data analysis phase. Gonzales (2012) has defined negotiation as reconciling the conflicting aims by the faculty in a striving university context, the context when universities aspire to become high ranked tier-one research university. In striving university context, research, publications, patents etc. become more valued tasks than teaching and societal engagement. The faculty, based on their identity and commitments, respond to striving differently. Negotiation is one type of response or faculty's agency when faculty start spending more time on research and publication but simultaneously they fulfill their societal commitments(p.345). Timo Ylikom was not tenured and he had different orientation than the university's traditions. Societal engagement was an important concern for him. In order to balance between research, publications, and his lobbying work, Ylikomi worked hard as he put it:

“I was working very hard in this time. There was so many things and my calendar was very much full at that time[when he was actively promoting the cell and tissue engineering research field]”.

Through his hard work, he tried to negotiate between two conflicting goals, producing research publications, on the one hand, and pursuing his passion and meeting societal needs, on the other hand. Nevertheless, it was not risk free. He paid the opportunity cost in the form of low salary for pursuing his passion and commitments. But he seemed satisfied in the low salary, because he was able to fulfill his societal commitments, as he commented:

“I am not very much paid. I don’t pay much attention as long as I could play some role. It just does not very much hurt me because I...so that if something happens [for instance, if he loses job etc.]then I would do something else”.

5.4 Actors’ Position

Riitta Seppänen-Kaijansinkko and Hannu Hanhijärvi were hired by the UTA and TUT to lead regenerative medicine research. It has already been described that they played key role due to their view of science, leadership style, foreign experience, and work experience in various fields. But some of the role they could play was mainly due to their leadership position in Regea Institute of Regenerative Medicine and BioMediTech respectively.

As an outsider with leadership position in BMT, Hanhijärvi was working closely with the Rectors of the two universities of Tampere. So, he was very effective in overcoming the doubts about regenerative medicine research. Hanhijärvi played key role in strengthening the commercialization of research due to his inclination towards commercialization and also due to his strong position in UTA and TUT. Finally, he was successful in getting “absolute trust” of everyone because he was “just to everybody”, claimed Hanhijärvi.

5.5 Actors’ Strategies

Researchers who had innovative ideas, they adopted different strategies to institutionalize their research ideas. It is, therefore, very important to understand the strategies the various actors employed to achieve their goals. In this section, some important strategies of different actors are analyzed.

5.5.1 Communication Strategy

The most important elements in the communication were disseminating the vision, transparency, and the strength of storytelling.

Communicating vision to diverse people

For Timo Ylikomi, the most important thing was communicating his vision, because it was important to get support of all the stakeholders. Commenting on the importance of communication or lobbying he said, “*it was important to get as wide shoulder possible for the process*”. So, “*I was doing quite a lot of lobbying work and also with Kalevi Lauslahti*”. Ylikomi was mindful that he would need support from different people at various stages of his endeavor as he put it: “*In many processes one*

needs different people and different characters at the different phase of the process: conception, starting, stable operation phases”.

In order to win support from various quarters, actors at different levels play different roles. Jari Hyttinen noted that people at different positions can lobby or communicate the purpose and mission of their research at different levels. Professor can spread in their circles but the head of department has access to different people and can therefore communicate with more influential people, as he put it:

“[it depends] what kind of role you played, if you are a professor then you can do your own part on many ways...if you have a position, like the head of department or something else, then you have ...other possibilities of persuading other people ... I have been ... the head of department, so during that time, [I looked] ... at the bigger picture and [tried] to persuade[people]”.

Ylikomi not only approached the right people, but also kept their interest in view to win their support. At tactical level, he followed a methodology called NABC (Need, Approach, Benefits and Competition). Following this methodology, he was able to identify the societal needs and the needs of different organizations in Tampere. He successfully engaged the heads of Tampere Hospital and FinMedi Oy, an organization responsible for promoting innovative businesses in Tampere. There was something for everyone in Ylikomi's presentations as shown in Figure 4.3 as Ylikomi commented, *“it was easy to sell because there was teaching, there was research, and there was business. So, you have all these key words”.*

Communicating Vision as a Story

Ylikomi propagated his vision as a continuation of a story. A long glorious story of synergy among teaching, research and commercialization in Tampere which had created a niche for Tampere in biomaterials industry. The story had then reached a new juncture where new opportunities had emerged on the horizon. The people from the Universities, Tampere Hospital, VTT, City of Tampere, and other organizations in Tampere could capitalize that opportunity, could become part of that success story and take it further. For Ylikomi, *“lobbying is a kind of a story telling”*. Talking about his communication strategy, Ylikomi said,

“People have a tendency to picture their life (past and future) in a narrative way. It is somehow easier to see one's life as a part of story instead of just a collection of separate, random happenings. So, when presenting people new ideas, it is beneficial to present the item so that it is a story in which the listeners are either already part or in which I am calling them”.

He explained the story in these words:

“In my presentations in late 90's and 2000, I presented that there is a story of tissue engineering in Tampere that started in early 80's with Pertti Törmälä (Professor of Biomaterials from TUT) and Pentti Rokkanen (Surgeon of Orthopedics). In my presentation, I proposed that we should continue the story by going into the new born field of real tissue engineering. In this new tissue engineering one would not use just passive biomaterials, but cells, biomaterials,

and bioactive compounds... In my presentations, I emphasized that when we make this story continue, big benefits (finally economic benefits) will come in Tampere”.

The story was further illustrated by the Figure 4.3 to make the story easily remembered. This figure shows the past achievements and future milestones. The story was not just a nostalgic call but was also a promise for future growth and development. Moreover, “*The story was easy to sell, because there was something for everybody: research, education and business*”.

Talking about the illustration he said, “*this chart was shown many years in this region*” to people in various organizations in Tampere and Helsinki. Ylikomi was also confident that he was following a right strategy. Recalling the success of his storytelling strategy, he summed up the response of a senior official in Tampere:

“I remember one important moment in the story telling process. It was year 2003 or 2004, when we went with [a senior official of Tampere who had already been persuaded by Ylikomi’s]... to ...[present]... the project [in an important office in Helsinki]. Then the official[from Tampere] insisted that he will present the project in the office in Helsinki. I was thinking, Yes!! Wow!! [Ylikomi gave a very strong triumphal gesture], now I/we have succeeded to sell the story in Tampere”.

Transparency in Communication

Transparency in communication was an important strategy of the actors during execution phase. Hannu Hanhijärvi communicated with the stakeholders in transparent manner to win their confidence and support. In dealing with funding agencies,

“we were very straight forward, we told that this is the issue where we say it’s not only research but we want to have product; we want to develop product. It is payback time now for the university. So, back to society something value. TEKES loved the idea. So we asked Euros 10 million and they gave us 10 million... (he laughed loudly expressing these views).... So, that was a good start”, said Hanhijärvi.

Like Ylikomi, Hanhijärvi also made a comprehensive presentation which he delivered at various forums in Tampere. The most important component of his presentation was his mission statement.

“...to take for assessment and further development the potential innovation emerging from research, as well as their appropriate protection for further commercial utilization.....” (Mission Statement of BMT)

Talking about it Hanhijärvi said, “*what we clearly... immediately talked, this is our mission statement. It is very clearly ‘innovation is equally important as education and discovery’ Not more important but equally because discovery is everything without discovery there is nothing*”. So, in his mission statement, he promised innovation and products. As a result, he was successful in getting funding from funding agencies. He delivered what he promised.

5.5.2 Breaking the silos of industry and academia

Four important characters of this case were Pertti Törmälä, Timo Ylikomi, Riitta Seppänen-Kajansinkko, and Hannu Hanhijärvi. Törmälä was from academia, but he had worked with industry since the start of his career. Ylikomi was purely from academia, Seppänen-Kajansinkko was a practitioner and Hanhijärvi came from industry. Although they had different background, they had a common strategy to focus on societal and market needs and not just focus on discovery research. So, all of them tried to bridge the gap between academia and industry, practice, and society. For Hanhijärvi,

“it was extremely important to understand that discovery is something, but innovation is something else.without the market knowledge you cannot make the innovation. So, you have to know what the [market] need is; for instance, when a new discovery is made, how do you interpret it as an innovation to the market. You have to do the market research, you have to do also IP research”.

5.5.3 Team work

For Pertti Törmälä, cooperation among talented and likeminded people is essential for the development of Science.

“The most important thing to have good cooperation with people. Everything which is today important nobody can do alone. There must always be cooperation. Cooperation with such people who share your views and already to share problems, difficulties to go forward and for believe that our common view is valuable, important. So, I think it is most important to have good cooperation with people. We have had always opposition. But the most important is that we worked with people who believe in the same goals what I see important”, said Törmälä.

For Pertti Törmälä team work is prerequisite in promoting scientific ideas.

“The big view what I believe that development of science is not logical, it is always question of cooperation with people. Even if something should seem very valuable for future development, if strong people don't find it good for cooperation, don't go forward”, said Törmälä.

5.6 Institutional Change

Emergence of regenerative medicine research field in Tampere is an instance of construction of a new research field, on the one hand, and a change in the existing field, on the other hand. It entails changes in the three pillars of the institution, namely regulatory, normative and cultural-cognitive pillars. The changes in the pillars can be identified by the changes in their associated empirical indicators. The three pillars and their empirical indicators are given in Appendix 1. Professor Markku Sotarauta has argued that for those who see institutionalization as a top-down process, institutions are regulations. However, a bottom-up view of institutionalization is actually an agency-centered process where cultural-cognitive pillar is very important. He has further noted that in the bottom-up view, changes in one pillar can affect changes in the other pillars. For instance, a change

in the in the cultural-cognitive pillar can affect changes in the normative and/or regulatory pillars. So, new standards, certifications, accreditations, or regulations are made. For Sotarauta, every formal decision is a change in the normative pillar of an institution. Similarly, a change in the normative pillar can consequently affect further changes in the cultural-cognitive and/or regulatory pillars of the institution. In this section, changes in the three pillars of the institution have been discussed using the empirical indicators associated with these pillars.

Changes in the Cultural-Cognitive Pillar

Three empirical indicators of cultural-cognitive pillars are given in Appendix 1. Scott (2013) has argued that when actors follow the “taken for granted” assumptions or a “shared understanding” in a culture, they get a positive feeling of “certitude and confidence”, while they get a negative feeling of “confusion and disorientation” when they don’t follow them. *“Actors who align themselves with prevailing cultural beliefs are likely to feel competent and connected; those who are at odds are regarded as, at best, ‘clueless’ or, at worst, ‘crazy’...”*(p.70). When Timo Ylikomi was pursuing his passion and was going countercurrent, nobody ever called him as “crazy” or “clueless”, however, the response which he got from various people was tantamount to calling him “crazy”. Because the “shared understanding” was discovery focused research. Even the academics who joined the regenerative medicine could not ignore the institutional norms, so some of them were very discovery focused which is evident in the quantitative survey. The survey was targeted to only those senior academics who had worked at Regea Institute of Regenerative Medicine or BioMediTech, because they got the opportunity to work in a different setting, where focused was rapidly changing from discovery to commercialization. Following are the survey results of the seven respondents:

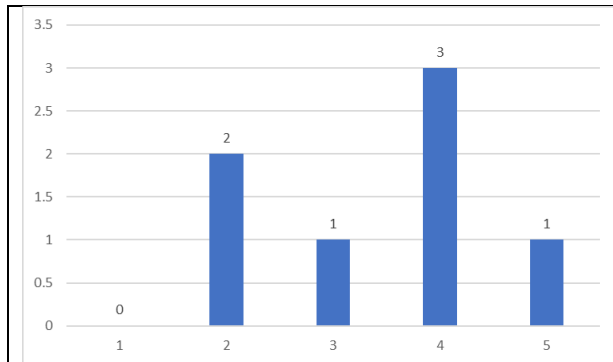


Figure 5.1: Survey result
Survey item: My main focus was big science/discovery when I joined Regea/BMT.

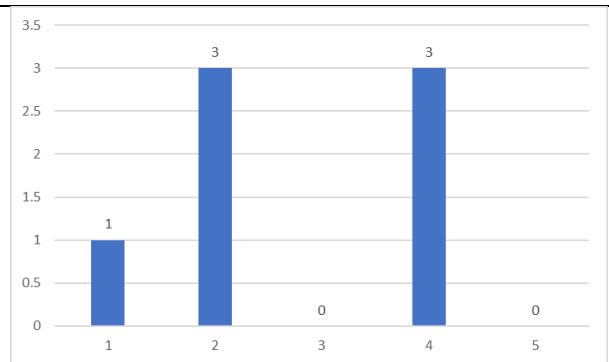


Figure 5.2: Survey result
Survey item: BMT as an organization was mainly focused on products/patents.

Figure 5.1 shows that most of the researchers agreed that their main focus was discovery when they joined Regea/BMT. However, Figure 5.2 shows that out of the thirty groups, which were part of BMT, there were still some who were focused on discovery.

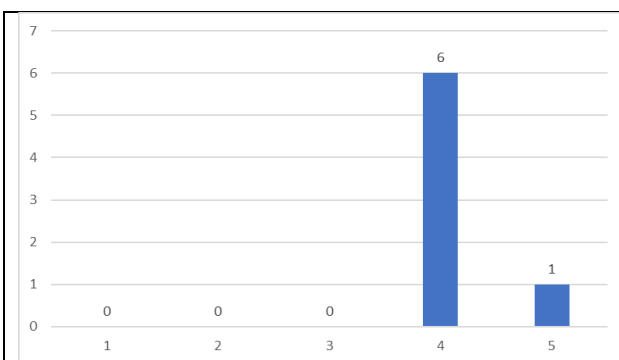


Figure 5.3: Survey result
Survey item: Training provided by Stanford Research Institute (SRI) has affected my approach toward research/science.

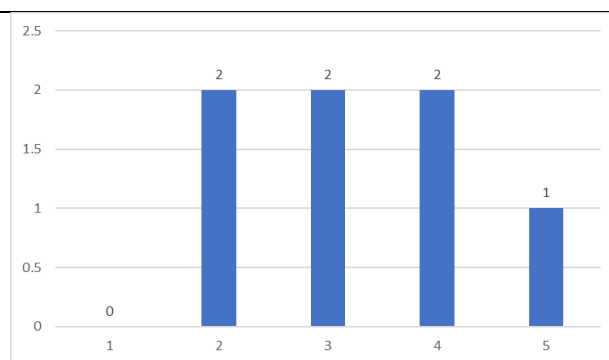


Figure 5.4: Survey result
Survey item: My focus has changed from discovery to products/patents since BMT was established.

Figure 5.3 shows that all of them agreed that the training provided by Stanford Research Institute (SRI) had an impact on their approach towards science. Figure 5.4 shows that some researchers are now more focused on commercialization than before.

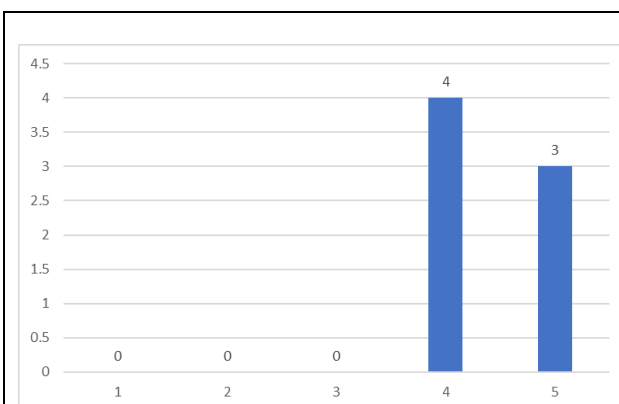


Figure 5.5: Survey result
Survey item: The purpose of my research is good science/discovery.

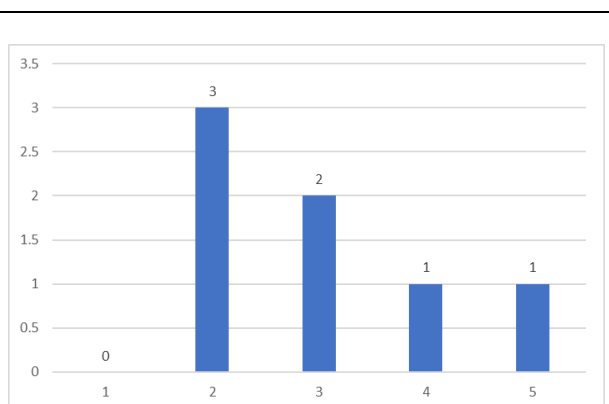


Figure 5.6: Survey result
Survey item: Purpose of my research is products/patents.

Figure 5.5 shows that all the researchers believe that the purpose of their research is to expand the frontiers of knowledge. In the comments, Susanna Miettinen explained her motivation:

“it is always the research interest that is kind of driving force”

Goddard et al. (2013) in a quantitative survey conducted on academics in six universities of UK, have also reached to similar findings that *“majority of respondents identified their fellow academics as the primary beneficiaries of their research”*.

However, some of the respondents have given conflicting views to the next item given in Figure 5.6. The conflict is resolved by the response given in the next two figures, which show their actual behavior or actions.

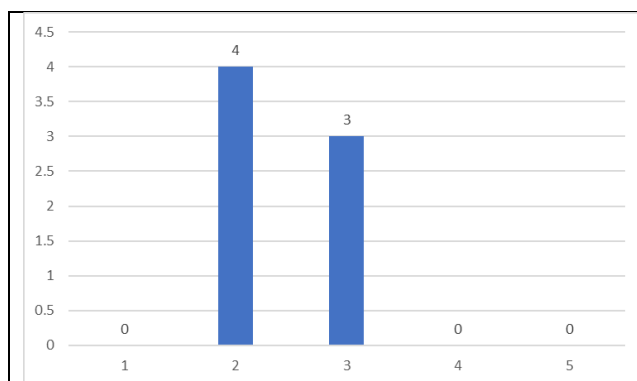


Figure 5.7: Survey result
Survey item: I am now more focused on commercialization(making products or patents) than discovery only.

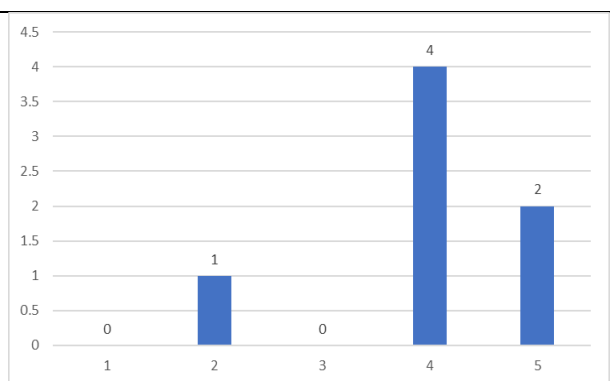


Figure 5.8: Survey result
Survey item: I am now equally focused on commercialization (making products or patents) and discovery.

Figure 5.7 and Figure 5.8 shows that the researchers are not focused more on commercialization, but are focused equally on both the areas with some exception. So, the *shared logic of action* has changed over time. The only dissenting researcher of UTA, shown in Figure 5.8, explained her position in the following words:

I think it is necessary to combine hard science and commercialization, but commercialization should not be the main focus in research conducted in universities. Basic knowledge is the key that leads to inventions and we should be able to build our commercialization projects on strong knowledge derived from basic research.

Summarizing the data of all of the above figures, it can be inferred that even in the regenerative medicine research groups, there were two categories of researchers who joined BMT. First, who were very discovery oriented; second, who were equally focused on discovery and commercialization. It is important to mention here that the second category was only from TUT. However, after working for thirteen years or so in regenerative medicine area, the researchers are now equally focused on basic research and commercialization.

The factors which contributed towards the change included the mission of BMT, Hanhijärvi's strong leadership role focused on innovation and commercialization, new mechanism to support the commercialization, strategic research funding provided by funding agencies, and the training provided by the SRI changed the researchers' approach towards innovation and commercialization of their research. Now most of them are focused equally on commercialization and discovery. This inference can be corroborated by the fact that in 2014, more than 60% of the funding of BMT was coming from outside source. TEKES and Academy of Finland were the two main funding bodies. TEKES gave funding mainly for strategic research (BioMediTech, 2015, p.8). While IMT, one of the biggest organization which had merged into BMT, had not more than 44% of external funding before its merger into BMT in 2010(IMT, 2010, p.9). So, it can be concluded that in 2014, the combined external funding of the research groups working in BMT had increased since 2011. Furthermore, the major portion of the external funding was earned for applied research from various funders.

Nonetheless, researchers believe that the purpose of the research done in the universities is to expand the frontiers of knowledge that can be a foundation for the inventions and commercialization. Without strong basic knowledge, commercialization is not possible. Hanhijärvi fully embraced these views.

“innovation is equally important as education and discovery. Not more important but equally, because discovery is everything without discovery there is nothing”, said Hanhijärvi.

It can be concluded that the **“shared understanding”** of the researchers towards innovation and commercialization has changed. Markku Sotarauta has also noted that the **culture** of the two universities are changing. In TUT, academics have now started valuing publications because many funding agencies value high impact factored publication. While academics in UTA are moving towards commercialization. The new generation of academics in both the universities are focusing not only on science and publications, but also on collaboration with industries. However, the debate of choosing between basic and applied research is ongoing. It is, therefore, difficult to quantify the level of the change as one researcher commented:

“[it is] difficult to say [that] attitude is changed towards applied research and innovation during last one decade. But in general, in Finnish universities the importance of innovation aspect has grown”.

In addition, there were doubts about regenerative medicine research at different stages. It was considered full of empty promises. However, gradually doubts were overcome due to various reasons. First, the successes of the researchers in the form of novel treatments built not only their own confidence but also helped overcome the doubts. They performed the first biggest surgery in 2007 which got worldwide attention. So far, they have treated more than thirty patients. Second, Susanna Miettinen has noted that the impact factor of the journals of applied field of regenerative medicine research was very low in the beginning. However, it has increased overtime. The resulting high impact factored publications have overcome the doubts and has changed the critics' view about the new field. So, in terms of prestige, the publications in regenerative medicine field has achieved a kind of **isomorphism** with the other fields. Isomorphism is one of the empirical indicator of the cognitive-cultural pillar. The above mentioned changes are proof of change in the cognitive-cultural pillar of the institution.

Changes in the Normative Pillar

As has been discussed in section 5.1.3 that for many years, there was low institutional support for regenerative medicine research. It included very little basic funding, absence of tenured positions for researchers, and other form of marginalization. Following changes helped institutionalization of the new research field:

- Establishment of a Steering Group comprised of important actors of Tampere (2003).
- Appointment of Riitta Seppänen-Kaijansinkko to lead regenerative medicine research area. Seppänen-Kaijansinkko was a practitioner (2003).

- Regea Institute of Regenerative Medicine established as part of IMT (Institute of Medical Technology) at UTA; amongst the founders were UTA, TUT, Pirkanmaa Hospital District, PIRAMK University of Applied Sciences, and Coxa Hospital for Joint Replacement **(2004)**.
- Establishment of Tissue Bank and Regea as an Independent Institution in UTA **(2005)**.
- Academy of Finland awarded Euros 912,000 funding for a three years project(2008-11) to the research consortium, called STEMFUNC, comprised of research groups from UTA and TUT working on regenerative medicines **(2008)**.
- Appointment of Hannu Hanhijärvi to lead a multidisciplinary research institute, called BMT, established jointly by TUT and UTA. Hanhijärvi had come from industry to lead an institute housed in UTA, which was highly research excellence focused **(2010)**.
- Merger of Regea and IMT into IBT **(January 2011)**.
- Establishment of a joint institute, called BioMediTech (BMT), by UTA and TUT to promote collaboration on multidisciplinary research themes, including regenerative medicines, which had commercialization potential **(August 31, 2011)**.
- TEKES granted 10 Million Euros funding for Human Spare Parts Project(regenerative medicine) being carried out at BMT**(2011)**.
- UTA adopts the same basic funding formula for all the research groups working in BMT, including the old research groups of former IMT(Institute of Medical Technology) and the newly established research groups working on regenerative medicines. It thus resolved the low basic funding problem **(2011-12)**.
- BMT hired many qualified managers to support research and commercialization activities. These included managers for project management, quality and regulation, business development, patent management & legal, and communications **(2011-12)**.
- An International Evaluation Panel evaluated/certified that the research carried out in BioMediTech has high quality and potential etc. It was part of Research Assessment Exercise of UTA, 2014 **(2014)**.
- Academy of Finland awards Euros 4.75 million competitive profile funding to UTA for supporting its effort to make human spare parts research(done by the researchers on regenerative medicine) as its priority research area. As a results, UTA announced seven tenure track position. One research group head working on regenerative medicine qualified for the announced position **(2015)**.
- Academy of Finland awarded Center of Excellence status to the consortium of six research groups(three from UTA and three from TUT) working on regenerative medicine **(January, 2018)**. It is a kind of certification or accreditation given by Academy of Finland. Certification or accreditation are two empirical indicators of normative pillar, given in Appendix 1,

All the above mentioned decisions by various organizations, funding bodies, and the two universities of Tampere are proof of changes in the normative pillar of the institution.

Changes in the Regulatory Pillar

Before 2014, regulations required extensive clinical trials of the new therapy/technology before it could be made as integral part of treatment in hospitals. However, following changes in regulations helped regenerative medicine research field:

- The new National Tissue Act and the European Union's Tissues and Cell Directive (2004/23/EC) paved way for getting support from PHD (Pirkanmaa Hospital District) for the establishment and empowering of Regea Institute of Regenerative Medicines **(2004)**.
- Amendment in Finnish Universities Act making interaction with society for promotion of scientific and cultural activity became part of University's mission(the so called 3rd mission) alongside teaching and research **(2004)**.
- Regulation 19/12/2014 Rec. no. 002646/00.01.00/2014 titled, "Regulation of the Finnish Medicines Agency (FIMEA) for Preparation of Advanced Therapy Medicinal Products (ATMP) for the experimental treatment of individual patients (Hospital Exemption)" promulgated. The regulation made it possible to make use of regenerative medicine for experimental treatments in the local hospitals **(2014)**.

Furthermore, official and researchers at Regea Institute of Regenerative Medicine and BioMediTech routinely contact the regulator, called FIMEA, to consult the legal issues. Thus the regulation has been evolving with the scientific innovation in regenerative medicine research.

The above mentioned regulations are the proof of change in the regulatory pillar of the institution. Although regenerative medicine is not yet institutionalized as a legitimate 3rd method of medical treatment alongside medicine and surgery, in the local hospitals of Finland, regenerative medicine research field has now institutionalized in the two universities and in the regional innovation system of Tampere. Only one decade ago, it was very difficult for researchers at UTA or TUT to get any substantial resource for the research in this field due to ambiguity about the potential of regenerative medicines. But now research in this area is institutionalized due to many of the changes mentioned above and due to its promising potential for society and economy.

Furthermore, it is clear from the analysis above that first changes came in the cultural-cognitive pillar of the institution where academic researchers and some other actors played a key role. These changes led to further changes in the normative pillar in 2003 with the establishment of Steering Group in Tampere. Changes in the normative pillar affected not only cultural-cognitive pillar but also further affected the normative and regulatory pillars. Change in each pillar engendered changes in the other pillars and in the same pillar itself. Thus it can be concluded that it was a bottom-up institutional change where some actors played a key role.

6 Conclusions

The purpose of this organizational level case study was to understand institutionalization of regenerative medicine research field in UTA as a bottom-up process in which the role of individual academics was of key interest. To achieve this purpose, this study was guided by the overarching question, how did some academics play key role in introducing and institutionalizing the regenerative medicine research field in UTA from 1986 to 2017? This question necessitated to answer the seven sub-questions. Section 6.1 will summarize the findings of this case study and offer conclusions based on the finding. Recommendations for practice are given in 6.2. Contributions of this case study to the body of knowledge are discussed in section 6.3. A self-reflection on whether or not the research questions mentioned in the first chapter have been answered is given in section 6.4. Recommendations for further research are given in section 6.5. Finally, limitations of this study are given in section 6.6.

6.1 Summary of Research Findings and Conclusions

6.1.1 Research Question

How did some academics play key role in introducing and institutionalizing the regenerative medicine research field in University of Tampere from 1986 to 2017?

Regenerative medicine is a multidisciplinary research field which has close connection with practice. Its emergence is a *divergent change* in the two universities of Tampere (UTA and TUT) and in the regional innovation system of Tampere because it has changed to a certain extent the “*rules of the game*”, has introduced many changes in the three pillars of the institution, and has broken the status quo in the research field of UTA in particular and of Tampere in general. It marked the beginning of new collaborations between universities, hospitals, regional government, development agencies, and R & D organizations. In this study, the roles of four important actors have been identified at various stages of emergence and institutionalization process of regenerative medicine research field in Tampere. As their role was pivotal in the institutional change, these actors can be called as *institutional entrepreneurs*.

While the early institutionalist have maintained that institutions determine the human actions, Delbridge and Edwards (2013) have argued that institutions have the power to constrain or enable the actions of agents, however, the impact of institutions is dependent upon the actors who “*variously conceive of and pursue their particular projects*”. The effect of institutions is contingent upon agents’ personal characteristics, their personal projects, and their relationship with the institutions. Through personal characteristics and their relationship with the institutions, actors in the same setting conceive different projects. Some of these projects are geared towards change while other support status-quo. Thus, institutions cannot necessarily have deterministic effect on agents. Amongst the personal level characteristics, actor’s motivation (for instance, emotion, passion, and commitments), their projective imaginations (hope or confidence in their projects), past histories, social positions, and their internal conversation play great role in building their capacity to introduce and institutionalize a change. In bringing the change, they are not merely at the mercy of institutional constraints and enablements, but actively exercise their agency.

In this case study, the role of four academics (Professor Pertti Törmälä, Professor Timo Ylikomi, Riitta Seppänen-Kaijansinkko, and Hannu Hanhijärvi) has been identified. Two of the academics, Professor Pertti Törmälä and Professor Timo Ylikomi, started playing their role in the first phase(2001-03) for the promotion and institutionalization of regenerative medicine without having formal positions in UTA or TUT. While the other two academics, Riitta Seppänen-Kaijansinkko and Hannu Hanhijärvi, played their key role in the second (2003-11) and third phase (2011-17) respectively after acquiring formal positions in UTA and TUT. This case study highlights that institutions can truly enable or constrain behavior, or can change aspirations, but that does not mean that institutions “directly, entirely, or uniformly determine individual aspirations”(Hodgson, 2006, p.7). Following answers to the sub-questions of this study will explain the role of the four academics in the institutionalization process.

Sub-questions 1: How did the regenerative medicine research field emerge in Tampere from 1986 to 2017?

Tampere has a long history of biomaterials which dates back to mid-1980s when surgeon Pentti Rokkanen and Professor Pertti Törmälä(TUT), started developing world's first bio-absorbable screws for healing bone fractures. They continued their inventions and developed many similar products based on bio-absorbable materials. Törmälä became an entrepreneur in his subsequent professional career. Although the field of regenerative medicine had emerged from US, he learnt about the new field through his project work in Tel Aviv University. He found many new possibilities of business in the emerging field which were not possible using passive biomaterials which they had been using thus far.

Timo Ylikomi is another professor from UTA who was working on hormone research. After reading two classic articles on cell & tissue engineering and stem cell published in Science Magazine(1993) and Tissue Engineering(2001) respectively, he became passionate about the emerging research field. He looked into it many new opportunities for the society, the University, and Tampere region in the emerging research fields. For him establishing the new research fields in Tampere was continuation of a story of success which was started by Pentti Rokkanen and Professor Pertti Törmälä. Although the two professors, Törmälä and Ylikomi, had different motivations, they started to promote the idea of establishing regenerative medicine research field in UTA, TUT, and in the whole Tampere region. At this stage, two other actors from outside the academia, Matti Eskola and Kalevi Lauslahti, also played important role by supporting and promoting the regenerative medicine research ideas. Both of them were persuaded by Professor Ylikomi. With their strenuous lobbying efforts, many people from Tampere Hospital, development agencies, university administrators, and academics started to realize the importance of the proposed field. Gradually, people from the various organizations started to jointly discuss the possibilities of working together. As a result, a Steering Group was established in 2003, which marked the beginning of the second phase(2003-11). The Steering Group was comprised of people from the three universities of Tampere (UTA, TUT, and Pirkanmaa University of Applied Sciences), Tampere University Hospital, Ministry of Health, Coxa, City of Tampere, and Tampere Hospital District. The same year, the Group head-hunted a maxillofacial surgeon, Professor Riitta Seppänen-Kaijansinkko, who was working in Helsinki. She has an entrepreneurial mind and is an eloquent speaker who wanted to develop products on the basis of new research ideas. In 2004, a cross-disciplinary research institute called Regea Institute of Regenerative Medicine was jointly established by UTA and TUT at the Kauppi campus of UTA. The institute got support from the regional development agencies and Tampere Hospital District for building a clean room facility and

a tissue bank. The year 2007 was very important for the researchers at Regea, because in a ground breaking surgery, they transplanted the upper jaw of a patient who had lost his upper jaw due to cancer. The upper jaw was developed using stem cell taken from the fatty tissues of the patients. In spite of great achievements, researchers working at Regea stayed marginalized in UTA. Seppänen-Kaijansinkko had strong connections in scientific community, knew the art of persuading, and had very strong motivation to promote the new research field. Through her eloquent presentations not only in scientific community but also on the mass media, she created awareness about the new research field and its benefits for the society. Acknowledging her contribution, TUT awarded her the title of Dr. Tech in 2012. However, the regenerative medicine research groups stayed marginalized in UTA.

The third phase started in 2011 when Regea was merged with another research institute of UTA, called Institute of Medical Technology(IMT). IMT was a big institute and was highly focused on basic research. It had strong support from UTA. Hannu Hanhijärvi became the Dean of the resulting institute, called BioMediTech. Hanhijärvi is pharmacologist who started his career from academia, but spent most of his professional career in leading R & D department of Finnish pharmaceutical companies and with venture capitals. With his diverse background in industry and business, he has an entrepreneurial mind and a strong leadership style. He had full support of the Rectors of the two universities in Tampere and could persuade the funding agencies due to his social network, clear mission, and open reporting policies. As a result, he was successful in providing financial and administrative support to the research groups working on regenerative medicines. Hanhijärvi left BMT in January 2017, but he played a key role in changing the focus of the researcher from basic research to both basic and applied research. On January 01, 2018, the consortium of the six research groups (three from UTA and three from TUT) working on regenerative medicine got Center of Excellence award from Academy of Finland. This award enhanced their prestige within and outside the academic community, on the one hand. It entitled them to receive Academy's financial support for the next eight years, on the other hand. The new field of regenerative medicine research has been institutionalized in Tampere to a great extent.

In conclusion, in this case four institutional entrepreneurs have been identified, namely Pertti Törmälä, Timo Ylikomi, Riitta Seppänen-Kaijansinkko, and Hannu Hanhijärvi. In the second and third phase, the role of Seppänen-Kaijansinkko and Hanhijärvi respectively was very important. In Tampere many people who know about regenerative medicine research field, they would name Seppänen-Kaijansinkko and Hanhijärvi as the key players in institutionalization process of the new field. But not many people know about the role of Pertti Törmälä and Timo Ylikomi. Seppänen-Kaijansinkko and Hanhijärvi played their role due to their personal qualities and cross-disciplinary work experience, on the one hand, and due to their organizational positions, on the other hand. Seppänen-Kaijansinkko was the Director of Regea Institute of Regenerative Medicines and had support from many key actors in Tampere. Similarly, Hanhijärvi was the fully authorized Dean of BMT. While both Pertti Törmälä and Timo Ylikomi had no formal position in TUT or UTA. Törmälä was a successful entrepreneur, but he had never worked in regenerative medicine field. Ylikomi was just an academic who had not even tenured position at UTA. However, Törmälä due to his vision and motivation to exploit new opportunities and Ylikomi due to his passion for the new research field, his societal commitment, and his vision played key role in the beginning when the new field seemed a science fiction for the academic super stars of UTA and TUT with whom Ylikomi and Törmälä were dealing with. Both Törmälä and Ylikomi have never worked in regenerative medicine research field before or after the field started to emerge in Tampere, but they had scientific hunch

that the new ideas are doable and have great potential for not only solving many health related problems but also have great business potential. Once Regea Institute of Regenerative Medicine, a formal organization focused on the new research field, was established the role of Törmälä and Ylikomi gradually diminished and the new actor, Seppänen-Kajansinkko took the lead henceforth.

Sub-questions 2: What were the institutional structures which were constraining the choices(human agency) of the academics trying to institutionalize regenerative medicine research field in Tampere?

Structure is a general word used for institutions in philosophy. While institutions are defined differently by various disciplinary scholars. Broadly, institutions (or structures) are “collection of rules and organized practices”, “system of established and prevalent rules”, “social obligations”, “shared understanding”, and “taken-for-granted assumptions” (Hodgson, 2006; March & Olsen, 2006; Scott, 2013). These scholars have pointed out that institutions can constrain certain actions and enable others. They can also affect the aspirations of the individuals, however, they cannot determine the aspirations. It was, therefore, necessary to identify the important institutional constraints and enablements. Important constraints were doubts about the new research ideas, difficulty in establishing collaboration between two important universities of Tampere (UTA and TUT) due to their different culture(institution), low institutional support for an applied field of research, and conflicting institutional expectations upon the researchers working in regenerative medicine field.

Emergence of regenerative medicine field in Tampere has been divided into three phases. Each phase had some distinct as well as some overlapping structures. In the first phase, when Pertti Törmälä and Timo Ylikomi were actively promoting the new research and commercialization ideas, doubts about the new research field and establishing research collaboration between UTA and TUT were the main constraints. Worldwide, regenerative medicine research field was emerging. However, for some academics it was full of empty promises. Proponents of new research field in Tampere were trying to sell ideas which were not yet fully developed. It was not easy for them to persuade the academic superstars of Tampere without concrete scientific evidence. Science and research were not yet institutionalized while they were talking about innovation and commercialization of the research. So, they were ahead of their time. Their ideas were not palatable for many people.

Next challenge was developing collaboration between UTA and TUT. The two universities had different culture. While TUT was more focused on innovation and commercialization, UTA was focused on scientific excellence. Due to different cultures, Törmälä faced little difficulty in persuading his former colleagues. He also had a successful track record of research, innovation, and commercialization, which had added to his credibility.

However, Ylikomi was facing an entirely different situation at UTA. On the one hand, he was confronting the skeptical attitude of his colleagues and senior. On the other hand, he was not getting support from his colleagues because he was going counter current. He wasn't following the “rules of the game” and “shared logic of action” in his university. Innovation and commercialization was not the focus of the academics at UTA. So, he would have been perceived, at best, as “clueless” or, at worst, as “crazy”.

As regenerative medicine research was a multi-disciplinary field, the collaboration between UTA and TUT was a prerequisite for its genesis in Tampere. But the two universities, due to their different cultures, way of doing things, and academics' mind-sets, were working in silos. The universities had strong rivalry and the proponents of regenerative medicine research had to overcome this barrier to materialize their ideas.

Establishment of Regea Institute of Regenerative Medicine marked the beginning of second phase. Role of Törmälä and Ylikomi diminished in the second phase and Riitta Seppänen-Kajansinkko took the lead. In the second phase a triple-helix arrangement of university-government-R&D Organizations was developed, excluding businesses. However, the new field of regenerative medicine was still marginalized at UTA. Seppänen-Kajansinkko due to her eloquent presentations at various academic forums and her press statements in the local and international media, created acceptance and fervor for the new field. However, the basic funding of Regea from UTA never increased above 20% of its total income from various sources. None of researchers in Regea had tenured position. Only Seppänen-Kajansinkko was getting her salary from UTA. Other researchers were dependent upon project funding for all their needs, including salaries. The low institutional support was further exacerbated by the conflicting demands on the researchers. The University wanted high impact factor publications from its researchers which were not possible in the beginning because the journal in the regenerative medicines had low impact factor. While the funding agencies, for instance TEKES and Academy of Finland, had started Strategic Funding schemes in which they wanted patents and products in their funded research. For the young researchers working on regenerative medicines who were not tenured, it was a challenging task to meet both the demands from the University as well as from the funding agencies.

In conclusion, in the first phase of regenerative medicines, the actors (especially Ylikomi) confronted skepticism and criticism from his colleagues because it was not possible for him to show the concrete evidence of the outcome of the proposed research field. In addition, the big difference in the culture and rivalry between the two universities (UTA and TUT) was also inhibiting any fruitful collaboration between the two universities. In the second phase, skepticism continued to some extent, but the new constraints also added to the list, including low institutional support and conflicting demand on the researchers working on regenerative medicine research. One of the main reasons for low institutional support was the resistance of other established groups which were involved in the excellent basic research. Due to the limited resources, it was not possible for the university to drastically cut the resources for the research groups which were considered the backbone of the University. Amongst the other reasons were the applied nature of the regenerative medicine and low impact factor of the journals in regenerative medicines. As the research excellence was the main focus of the university, it was not easy for the management to divert resources towards the new applied research groups which had low scientific prestige in terms of low impact factor. The researchers had to reconcile the diverging expectations from the university as well as the funding agencies on whose financial support they were surviving. For continuity of their service contract, they could not afford to ignore the university's expectations in terms of high impact publications. In the 3rd phase many of the constraints were waned.

***Sub-questions 3:** What were the institutional factors which were enabling the choices (human agency) of the academics trying to institutionalize regenerative medicine research field in Tampere?*

As discussed in the previous section, it is necessary to identify the institutional enablers for studying the divergent institutional change. There were two categories of enabling conditions. The first category was of those factors which were present in the immediate institutional context. For many years, the two universities had different culture and the their academics had different mind-set. The academics at UTA were focused on basic research while academics at TUT were focused on applied research. These factors had triggered a rivalry between the two universities and the possibility of collaboration between the two universities were bleak. However, in the recent years the culture within the two universities has started to change and now both are moving, though very slow, toward the center of the spectrum. The changing culture is creating nurturing ground for the new possibilities of collaboration. After the establishment of Regea Institute of Regenerative Medicine, the cohesive and supportive culture between the various research groups, both from UTA and TUT, created an enabling environment for the young researchers. Although the research groups were not getting the required support from their universities, they could easily share their problems, get moral support from each other, and collectively solve some of problems.

The second category of enablers were comprised of those factors which had emerged in the broad inter-institutional context, including Tampere, Finland and the Europe. There were growing expectations amongst the research worldwide that the regenerative medicine can provide solution to many health related problems. This positive image of regenerative medicine helped the researchers to get support from their respective universities, though at a very low pace, and from the other organizations within Tampere. Some intermediary organizations in Tampere, for instance FinMedi Oy, provided technical support to the proponents of the new research field. FinMedi Oy connected them with the influential actors in Tampere region. In the second phase, which started after Regea was established, the emergence of Triple Helix of University-Government-R & D organizations also created conducive environment. Tampere Hospital gave funding to Regea to support research infrastructure of the newly established organization. Local government organizations also started cooperating in the new research field with the hope that the new research will provide innovative forms of treatments. They were also suggested by various actors that there were great chances of commercialization and Tampere can emerge as business center for bio-technology. In 2017, UTA has started collaboration with Stanford University's SPARK Program to learn commercialization of the new research in regenerative medicine field.

The new regulations on "safe human and tissues & cell for transplantation" and regulation on "advanced therapy medicinal product(ATMP)" which were promulgated by the European Union motivated the Finnish government to adopt these regulation in Finland. Due to the new regulations, Tampere Hospital District decided to outsource its tissue bank to Regea and Regea was also able to get clean room facility which was financed by the BioneXt Program(2003-2010). The new regulation also allowed the doctors and professor to test the new forms of treatment without going through all the test phases of developing conventional medicines. Moreover, some existing Finnish regulations encouraged the doctors to take the risk and test the newly developed treatments in Regea on their patients who otherwise had no treatment option. In the case of patient's death, it is the liability of the hospital and not the doctors to compensate the patient. New Strategic funding schemes of Academy of Finland and TEKES also supported the researchers in Regea and then BMT to engage in applied research area. In strategic funding, the funding agencies expected innovation and products as the outcome of the research.

In sum, although the immediate institutional context had raised many impediments for the nascent research field, the same institutions provided some enabling conditions. While some of the enabling conditions had come from the immediate institutional context, the broader context of Finland and European Union offered other enablers. However, it was not simply the interplay of institutional constraints and enablements which was affecting the new research field. The institutional constraining or enabling causal powers became active only when certain actors had projects of specific nature. In the absence of such projects, the institutions, in spite of their potential, would have not offered enablements or constraints. In this case, some academics had projects (of establishing regenerative medicine research field) which had triggered the enablements and constraints of the institutional structures. Through their reflexive deliberation and projective orientation, they had not only conceived those projects, but could also overcome the constraints, on the one hand, and capitalized on the enablements on the other hand.

***Sub-questions 4:** What were the motivations (passion, commitment, identity, and emotion etc.) of the key academics in promoting and institutionalizing the new research field?*

Battilana et al. (2009, p.91) in their literature review have pointed out that various scholars have identified the individual factors of institutional entrepreneurs for introducing divergent change. Some of these factors are emotion, passion, and commitments (Gonzales, 2015, p.308). So, for this study it was considered important to investigate those personal level factors. With the advent of tissue engineering in US in 1990s, some academics of UTA and TUT became keen about the new research field due to multiple reasons. They had range of motivations, such as passion and curiosity about the new research field, commitment to contribute towards society by offering novel medical treatments (for instance, making new human bone for healing defects) which were engendered by the new research field, and commercialization potential of the new research. Some academics' background experience affected their choices. For instance, those who were involved in businesses or practice (for instance, Pertti Törmälä, Riitta Seppänen-Kaijansinkko, and Hannu Hanhijärvi) were more interested in the commercialization potential in of the regenerative medicine. Timo Ylikomi was one of the important, but least known actor. He played a key role in the beginning. Although he had no entrepreneurial experience, he got interested into the new field due to his passion, curiosity, or societal commitments. Even if he was interested in the commercialization potential of the new research field, it was due to his societal commitments; earning money was not his main objective. Similarly, a research group leaders (Susanna Miettinen, for instance) who joined the regenerative medicine field in 2004 and onward had varying motivations, including curiosity in the new field and the relevance of their research for society.

In sum, while some researchers entered into the new research field after carefully doing cost and benefit analysis (evaluating their strengths and the benefits in the new field), others didn't perform such cost-benefit analysis. They simply got passionate about the new research field because it was a promising field. They could quickly see the outcome of their research in the form of novel treatments for the patients who were otherwise had no treatment options. These passionate researchers also felt satisfaction on the benefits accruing towards society due to their research endeavors. For them, societal contribution, no matter how small, was more important than simply supervising PhD students. Their passion and societal commitments helped them overcome the institutional constraints and capitalize on enablements.

Sub-questions 5: *How actors' projective imaginations(hope, vision, and confidence), internal conversation, past histories(such as past work experience), and social positions helped them to navigate the social structures for institutionalizing the regenerative medicine research field in Tampere?*

In this case study, all the key academics had envisioned new possibilities of research, innovation, and commercialization. These possibilities had social, commercial and professional implications. Their conviction about the possibility of new treatments, new businesses, and an economic niche for Tampere was an important motivating force. So, in terms of agentic orientation, the key academics had projective orientation(Emirbayer & Mische, 1998, p.983). Hope and confidence are important dimensions of projective imaginations. Although none of the key academic had ever worked in the regenerative medicine research field, their conviction and confidence greatly helped them.

In order to pursue his projects, Timo Ylikomi, who was promoting the idea in UTA in particular and in the whole Tampere in general, had strong autonomous internal conversation. With his autonomous internal conversation, he didn't succumb to "*shared logic of action*" and ignored the discovery oriented culture of UTA where aim was to serve the scientific field. Societal service was not a priority of the academics. But Ylikomi went counter current in pursuing his future projects. He completed his internal conversation "*at a distance*" from the existing arrangements (or the organizational culture), therefore, led to "*contestation with the incumbents*". Pertti Törmälä seemed a communicative reflexive who considered a strong team of likeminded people as a prerequisite for any innovative project. He was able to capitalize on his network from TUT where people were already focused on innovation and commercialization.

Many key actors(Ylikomi, Törmälä, Hyttinen, and Hanhijärvi) had worked in foreign countries before joining the regenerative medicine research. It is not known whether Seppänen-Kajansinkko had ever worked in a foreign country or not. However, it is important that those actors who had worked in foreign countries, they learnt about new research opportunities (Törmälä), or new ways of doing things (Hyttinen), or different ways of doing research (Hanhijärvi and Seppänen-Kajansinkko).

Many factors helped Seppänen-Kajansinkko and Hanhijärvi to follow a divergent path, including their personal qualities, experiences, and leadership position in Regea and BMT respectively. For them joining UTA was a "*contextual discontinuity*", which also added to their effectiveness in the university setting. As they had come from practice or industry, they had not rich ties with the people in the new setting and had not strong commitment with the scientific excellence focused culture of the university. Hanhijärvi autonomously decided many things and rarely succumbed to the pressures. Similarly, Timo Ylikomi's autonomous reflexivity was one of the reason that he could conceive future projects which were not aligned with the incumbent institutional culture.

In conclusion, there were various individual level factors which helped the key actors to institutionalize a divergent change. These individual factors were of social and psychological nature and had also causal powers which could overcome the casual powers of institutional constraints.

Sub-questions 6: *What were the strategies which the key actors adopted for promoting and institutionalizing the new research field?*

Battilana et al. (2009) have noted that many scholars have studied the various strategies adopted by the institutional entrepreneurs to introduce a divergent change. Considering institutional entrepreneurship as a discursive strategy, these scholars focus on the stories, discourses and text generated by the institutional entrepreneurs to introduce the change (p.94). So, it was important to investigate the strategies of the key actors. The key actors adopted three important strategies for institutionalizing the regenerative medicine research field in Tampere, including communication strategy, bridging the gap between the researchers and the user(whether market or society), and team work. Three actors, Timo Ylikomi, Riitta Seppänen-Kaijansinkko, and Hannu Hanhijärvi gave great weight to the communication. They ensured to communicate their vision to as many people and organizations(within government and outside the government) to harness support from all important quarters, to overcome doubts about the new research field, and to apprise the audience about the possibilities which the new field was offering. In order to get support of various actors from academia, research organizations and businesses, Ylikomi spread the vision in form of a glorious story which had started in Tampere in 1980s with Professor Pertti Törmälä and Surgeon Pentti Rokkanen with their discoveries and subsequent commercialization of those discoveries in biomaterials. The story had then reached to a new juncture. The continuation of the success story was vital for all the quarters because there was something for everyone. Ylikomi's vision(presented in the form of a story) had teaching, research and business. Finally, in communication strategy transparency was the important thing when the research gained the pace. Transparency was the key stone in Hannu Hanhijärvi's dealing with funding agencies. He was very open in reporting the output of the projects executed by BMT and he delivered what he and his researchers promised. Due to his transparent communication and just leadership, he was successful in winning the trust of the internal and external stakeholders. He successfully got huge funding from TEKES and Academy of Finland.

In order to ensure that the research done in BMT is relevant for industry and society, all the key actors(Timo Ylikomi, Pertti Törmälä, Riitta Seppänen-Kaijansinkko, and Hannu Hanhijärvi) tried to bridge the gap between academia, society, R & D organizations, and businesses. They successfully broke the silos in which UTA and TUT were working. In addition, they brought all the stakeholders in Tampere closer to each other to promote the new research field. Finally, some key actors, such as Pertti Törmälä, deemed team work essential for the success for all endeavors. For him, without team work, no project is worth doing.

In conclusion, successful actors conceive projects to meet their valued ends. To achieve those ends, they also devise effective means or strategies. In the beginning when the idea is new, it is important to eloquently communicate the vision to a broad audience. To rally their support, it is further necessary to keep their interests in view. Once the projects get started, it is essential to be transparent and ethical in dealing and communicating the outcome of the projects. Transparency ensures the consistency of support and to win further allies. For the research done in universities, it is necessary for the universities to know the societal and market needs in setting their research agenda. By identifying the needs, they can form a team which can ensure the success of the projects.

Sub-questions 7: To what extent regenerative medicine research field has been institutionalized in Tampere?

For Scott (2013) Institutionalization is a process. Using Scott's "omni-bus" model of institutions, changes in the three pillars of the institution have been identified in this case. Since the emergence of regenerative medicine (regenerative medicine) research area in US, a few academics (Timo

Ylikomi and Pertti Törmälä) started promoting the idea of regenerative medicine research in Tampere. They had no formal positions in UTA or TUT. However, their strenuous efforts brought initial changes in the cultural-cognitive pillar of the institution. As a result, the influential people in Tampere started to realize the importance of regenerative medicine research field. A change in the cultural-cognitive pillar stimulated changes in the normative pillar with the establishment of Steering Group in Tampere comprised of actors from various organizations. These changes were then combined with the regulatory changes at the level of EU and Finland and facilitated the financial support from Tampere Hospital and regional developmental programs to establish the necessary infrastructure in the form of clean room facility at UTA. UTA, which had a culture of scientific excellence, appointed a practitioner, Riitta Seppänen-Kajansinkko, in 2003 to lead the regenerative medicine research group. Her appointment was a manifestation of not only a big normative change, but also of cultural-cognitive change. The next year marked big changes in the normative and regulatory pillars when Regea Institute of Regenerative Medicine with the joint collaboration of UTA, TUT, Tampere Hospital, Pirkanmaa University of Applied Sciences, and Coxa was established. Through her persuasive speeches, Seppänen-Kajansinkko would have brought changes in the cultural-cognitive pillar. The same year, Finnish government enacted an amendment in the Finnish University Act which made the societal service as part of the universities' mission alongside teaching and research. The new amendment made it necessary for academics to engage in research which has direct societal relevance, such as regenerative medicine. A chain of normative changes started in 2011 when BioMediTech, joint research institute of UTA and TUT, was established and Hannu Hanhijärvi became its head. Establishment of BMT triggered many changes, mainly in the normative and cultural-cognitive pillar of the institution. Regenerative medicine research groups came out of marginalization, new funding came for applied research in the field of regenerative medicine, basic funding from UTA increased, and support staff was hired to facilitate the innovation and commercialization. The biggest funding of Euro 10 million from TEKES for the Human Spare Parts Project and Euro 4.75 million from Academy of Finland for profile funding were profound changes in the normative pillar. Finally, the biggest change in the normative pillar came in 2017, when Academy of Finland bestowed Center of Excellence award to the consortium of six research groups working on regenerative medicine in Tampere. This award entitles the research group for financial support but has also elevated their prestige. All the changes in the regulatory and normative pillar are stimulating further changes in the cultural-cognitive pillar. Researchers who joined regenerative medicine field in 2004 were also discovery oriented in the beginning. But not only their own views but also their image in the eyes of researchers in other fields has been changing. Important factors, which have contributed to the change, include their own achievement in the form of novel treatments for patients who had no other options of treatment. Also, with the entrepreneurial leadership of Hannu Hanhijärvi they started to focus equally on discovery as well as commercialization. Furthermore, with increase of the impact factor of the journals of regenerative medicine, the image of regenerative medicine will be elevated in the eyes of researchers in other fields.

It is important to note that Hannu Hanhijärvi had organized a high level training for all the research group heads working in BioMediTech. This training was provided by the trainers from Stanford Research Institute(SRI), a non-profit research institute headquartered in California, USA. The main ideas of this training can be read in the book titled, *"Innovation: The Five Disciplines for Creating what Customers Want"* written by C.R Carlson and W.W.Wilmot. The trainers emphasized that the researchers in any field should follow a methodology, acronymed as NABC(Need, Approach, Benefits and Competition). According to this methodology, the research should identify the societal

“Need” before choosing their research topics, then assess their “Approach”, clearly identify the societal and economic “Benefits”, and compare their research with the solutions provided by the “Competitors”. In the quantitative survey conducted for this thesis, all the respondents “agreed” or “strongly agreed” that the training provided by SRI had positively affected their approach towards science and research. In the interviews also, some researchers acknowledged the impact of the said training on their approach. Nevertheless, the quantitative survey also showed that all the researchers unanimously agreed that the purpose of their research is to expand the frontiers of knowledge. Their research interest is the main driving force behind their research. Goddard et al. (2013, p.8) in a quantitative survey conducted on academics in six universities of UK, have also reached to similar findings that *“majority of respondents identified their fellow academics as the primary beneficiaries of their research”*. Goddard et al. (2013) have pointed out that this approach of academics’ has serious implications for universities’ societal engagement. In order to enhance the universities’ societal engagement, this approach is needed to be changed.

In sum, emergence of regenerative medicine research filed in Tampere is a non-deterministic development in the UTA in particular and in the regional innovation system of Tampere in general. Because the focus of UTA was on discovery and scientific excellence on the one hand, and most of the research superstar of UTA were not favoring the new research field, on the other hand. Further, many changes in the three pillars of the institution mentioned in the preceding paragraphs signify that regenerative medicine research field has been institutionalized in UTA. In the culture of UTA, regenerative medicine research has now more acceptance than before because *“shared logic of understanding”* is changing. The university is now highly motivated to capitalize the research for commercialization and has started to collaborate with Stanford University’s SPARK program.

6.2 Recommendations

1. In the conclusions to sub-question 4 and 5, it was stated that one academic, Professor Timo Ylikomi, played his key role because he was fascinated by the possibilities which the regenerative medicine research area was offering. He became not only passionate about the new field, but he envisioned to solve many health care related societal challenges. His societal commitment was an important source of his agency. Based on these insights from the case, it is recommended that the Finnish universities should identify such people in their cadres and let them peruse their societal projects which are not necessarily aligned with the existing research excellence culture. For making Finnish universities globally competitive but locally engaged, it is essential to support people like Professor Timo Ylikomi.
2. Keeping Timo Ylikomi’s example in view, it is also essential for Finnish universities to develop new leadership which can have *“courage to lean on the invisible...lean on something that is not yet there, but what [they] believe is possible”*. They must have a strong vision. For promoting innovation, risk taking attitude should also be encouraged.
3. In conclusion of sub-question 5, it was stated that some of the key academic who played pivotal role had either foreign work experience or they had worked in a different sector of economy. Through these works, they learnt about new ideas, new ways of doing things, or internalized different cultural values. On the basis of these conclusions, it is recommended that Finnish universities should make changes in their human resource strategy. First, they should ensure to hire foreign nationals in faculty and researchers. Second, they should prefer those Finnish who

have foreign work experience, especially in the teaching, research and other areas where divergent changes are required, for instance, technology transfer offices. Finally, the universities should also hire academics who have prior work experience in other industries. People who come from other sector may easily identify the institutional contradictions and intend to change the prevailing practices. They can also capitalize the opportunities in other fields using the resources available to them in the new field.

4. Furthermore, In the conclusion to sub-question 1 and 2, it was stated that establishing collaboration between UTA and TUT was a challenge. In spite of the Rectors' commitment, it took a long time to establish real research collaboration. It was further noted that actors, such as Timo Lahti, who was chief administrative officer of UTA provided significant support for promoting regenerative medicine research field. Timo Lahti had previously worked in ministries, he evaluated the new proposals differently than research superstars and agreed to provide support to the exponents of regenerative medicine. Based on this example, it is important that universities should hire people, especially at the strategic positions and at university boards, who have work experience of other sectors. They will bring fresh ideas which can break the ivory towers of higher education.
5. One of the conclusions of sub-question 7 stated that all the respondents agreed in the quantitative survey that the purpose of their research is to expand the frontiers of knowledge. Another conclusion of this sub-question stated that all the respondents "agreed" or "strongly agreed" in the quantitative survey that the training provided by Stanford Research Institute(SRI) had positively affected their approach towards science and research. From these conclusions, it is recommended that the Finnish universities should challenge the basic notion of purpose of science by starting a new discourse on the purpose of science. This can be achieved by organizing workshops and seminars on 3rd mission of universities. The universities should also organize high level trainings for their academics to affect their approach towards research, innovation and commercialization. These trainings can change the mind-set of the academics by challenging their view about science, on the one hand, and can give them other perspectives to conduct research, need and possibilities for innovation, and their societal obligations, on the other hand. The proposed trainings, if delivered effectively, can help the universities to achieve their societal engagement mission which was included in the Finnish University Act in 2004. Without changing the academics' view about science, the achievement of the so called 3rd mission would remain a distant dream for Finnish higher education.
6. In the conclusion to sub-question 1, the names and roles of the key academics have been identified. In conclusion to sub-question 2, it is explained that the key actors faced some institutional constraints while they were promoting their innovative ideas. In conclusion to sub-question 3 and 4, the it was further explained that some actors could play significant role, without having formal positions, due to their passion and commitments. Finally, in the conclusion to sub-question 7, it was stated that regenerative medicine research has now become a success story in Tampere, especially after award of Center of Excellence status. Based on these conclusions, it is recommended to the faculty and managers working in higher education that they can pursue their ideals, passion, and societal commitments and achieve those goals which the institution is not supporting at the moment. As in the introduction chapter of this thesis, it was described that higher education is going through massive reforms and public financial support is shrinking

rapidly in many countries. It is therefore very necessary for the managers and academics to learn how to exercise agency in the “striving university context” where the focus of the universities is to raise their status in the global rankings. Teaching and societal engagement have been relegated to lower level tasks which many academic and research superstar might not be interested in. It is very important for the academics and managers to have aspirations which may be counter current. Through emotion, passion, commitment, confidence, and hope, they can achieve their aspirations. As one Pakistani poet said:

*Don't fear the intensity of opposing-wind, O' Eagle
It only blows to help you fly even higher*

The poet has used eagle as a metaphor in addressing those who have high aspirations. However, it is essential that they follow the successful strategies adopted by the key actors in Tampere. For instance, it is essential to garner support of people who holds resources. To win the required support, it is vital to develop a narrative of change which can be appealing and understandable for influential actors.

6.3 Contribution to Knowledge

Using a synthesized theoretical framework, this study has two different types of actors. Many people in Tampere would give credit only to Professor Riitta Seppänen-Kaijansinkko and Hannu Hanhijärvi for their key role in institutionalizing the regenerative medicine in Tampere. There is no doubt about the role they played. However, using the theoretical framework which incorporated both rational as well as intentional, based on Archer's concept of human agency, motivation factors, this study could identify one additional actor which would have been missed without the use of the synthesized theoretical framework given in chapter two. The additional key actor is Professor Timo Ylikomi who has been identified in this research. It is an important contribution of this thesis. Based on this key empirical findings, recommendations are given above that such actors can be an important asset for Finnish universities, especially in meeting university's societal engagement mission. This contribution is highlighted further if institutionalization of regenerative medicine is seen from system thinking approach.

Professor Esa Saarinen from Aalto University in one of his lectures on “systems thinking” has described system thinking approach using an example of ice hockey. In ice hockey, the spectators take two movements into account. First, who made the goals. Second, who passed the puck to the person who made a goal. It is often forgotten that these two persons do not work alone, but are influenced by the whole team – the system. Saarinen in his said lecture has described the effect of team or system with a term, “the third dimension”. He has argued that if the game is analyzed as a whole system, the influence of the third dimension can be seen. However, humans are generally not able to analyze the whole system as the game proceeds. They simplify things and give credits only to the person who makes goals and to the one who passes the puck to him/her.

It is possible that now or at least after a few years, many people in Tampere or in Finland may think that there were only two important actors who played the key role in establishing regenerative medicine research field in Tampere: Professor Riitta Seppänen-Kaijansinkko took the puck, moved it towards the goal post, and passed it to Hannu Hanhijärvi, who made the goal. However, in this thesis, it is important that the researcher has identified the third dimension by grasping the whole

system starting from Professor Pentti Rokkanen and Professor Pertti Törmälä and proceeded to the players in the early 2000, including Timo Ylikomi, to the contemporary researchers working in the newly established Center of Excellence for Body-on-Chip research.

This research has also added to the body of knowledge on “civic universities”, the idea which Goddard et al. (2013) have been promoting to develop globally competitive but locally engaged universities. The idea of civic university and consequently the insights this thesis has brought are very important for Finnish higher education system which is struggling with promoting the ideas of societal engagement, their so-called 3rd mission alongside teaching and research.

Furthermore, this research has identified the role and importance of some other actors from outside academia, for instance, Matti Eskola and Kalevi Lauslahti. These actors qualify the definition of “Leadership of Place”, another idea which Goddard and Vallance (2011) have developed to understand the engagement between university and society.

Finally, contrary to Battilana et al. (2009), this thesis has identified actors who could play their role without any social position. In identifying these actors, this study has avoided all forms of conflation between agency and structures: upward conflation (methodological individualism), downward conflation (methodological collectivism), or center conflation. For instance, the intentional actors, Timo Ylikomi for instance, were operating within the bounds of the institutions. But due to their commitments and passion, they achieved those targets which were not possible within prevailing circumstances.

6.4 Self-reflection

The beginning of this research was very chaotic and vague. This researcher was interested in the philosophical debate between structure and human agency and also about critical realism. Professor Bernard Leca from ESSEC Business School in France suggested a very useful theoretical framework, however, it was comprised of so many abstract concepts which were new for this researcher. In the first few thesis presentations, all the faculty had a smile on their face because they thought that it would be very difficult for this researcher to conceptualize, operationalize and collect empirical evidence on so many abstract concepts which were new for this researcher. However, with passion, commitment, and extensive contacts with so many scholars within UTA and in other countries, things started to become clear. Next challenge was to develop a questionnaire or protocol to conduct the interviews. The challenge was aggravated with the fear that the interviewees will be experts in regenerative medicine research area and will be senior professors. Three of the interviewees of this research were more than seventy years of age. This researcher was also very shy in asking bookish questions according to the themes of the theoretical framework.

However, after a few interviews, things became easy and the researcher got the confidence. Thanks to the friendly attitude of Finnish academics towards junior researchers. In the beginning, some of the academics didn't promptly respond to the email request sent to them for interviews. But when those academics were contacted by reaching out to their offices, they happily accepted the request for interview. So, the first piece of advice is to knock the doors of your prospective interviewees, if you don't get response within a certain time. This researcher acknowledges that the literature review was not done very systematically. Furthermore, this researcher initially spent a lot of time reading the transcript on hardcopies. Soon it was realized that collecting the data from various interviews on

each theme would be a cumbersome process. So, the researcher finally decided to use NVivo, a qualitative data analysis software by QSR International. Although the licensed version of the software is very expensive, its trial version can be used for master dissertation. Life really becomes easy with NVivo. In fact, NVivo can also be used for literature review. On the basis of qualitative data analysis, this researcher developed a quantitative survey comprising of more than forty questions. However, during the analysis phase of the quantitative data, it was realized that most of the questions were not rightly asked, so the replies were not included in the analysis. The reason for this mistake was that the researcher had left Finland and was located in his home country. Therefore, regular contact with supervisor was not maintained. Thus, it is recommended to the novice researchers that maintaining a regular contact with the supervisor is must to avoid wastage of time and developing a coherent piece of research. This researcher also acknowledge the weakness in academic writing, especially writing succinctly. Finally, this researcher recommends that before conducting any case study, the researchers should carefully decide whether or not the written report of the case would need to be anonymized. For anonymization, the researcher should consult the University's ethical committee prior to conducting the research.

6.5 Further Research

Based on the quantitative survey, which was conducted as part of this thesis, it was noted that many funding agencies have started to focus on innovation and commercialization as their main objective in research funding. On the other hand universities want high impact publications to elevate in ranking. So, there seems an apparent contradiction. However, it is important to see how faculty exercise their agency to deal with this apparent contradiction. In further research, it can be investigated how organizational values change when the focus of an organization changes from basic to strategic or applied research. Finally, it is important to conduct a detailed study on the effectiveness of academics who have foreign work experience in promoting university's societal engagements. A similar study should also be conducted on academics and managers of higher education who have previously worked in different sectors of economy to understand their effectiveness in developing societal engagement. The proposed studies will help the Finnish universities to realize their so called 3rd mission.

6.6 Limitations

Although this research has achieved its purpose to understand the institutionalization process of regenerative medicine research filed in UTA as a bottom up process, one must acknowledge the limitations of this study. Some actors could not be interviewed, for instance, some academics of UTA who were named as strong proponent by Timo Lahti or those academics who were critical about the new research field. Similarly, it was not possible to conduct interview of Kalevi Lauslahti due to limitation of time. Similarly, due to limitation of time, it was not possible to conduct the interviews of the critics of regenerative medicine research in Tampere. Furthermore, during the interviews, this researcher could not collect detailed data on some themes.

Moreover, to understand the interplay of agency and structure, relational sociology was one of the key element of the theoretical framework developed by Delbridge and Edwards (2013) connecting various levels of reality: real, actual, and empirical domain. However, as the author has not studied relational sociology, therefore, this element was eliminated from the framework. Similarly, the concept of institutional logic, which was another element of the framework, could not be utilized.

Nevertheless, the researcher intend to utilize these concepts in his doctoral research. As UTA had research excellence and most of the academics were not inclined towards applied research, the constraint faced by proponents of this regenerative medicine in Tampere can be specific to UTA. While academics involved in a similar activity but in a different university which can have different culture, may not face the same constraints. So, the recommendations given in this study may not be relevant for every Finnish university.

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Appendixes

Appendix 1: Three Pillars of Institutions (Scott's Model)

	Regulative	Normative	Cultural-Cognitive
Basics of compliance	Expedience	Social obligation	Taken-for-grantedness, Shared understanding
Basis of order	Regulative rules	Biding expectations	Constitutive schema
Mechanism of control	Coercive	Normative	Mimetic
Institutional Logic	Instrumentality	Appropriateness	Orthodoxy
Empirical Indicators	Rules, Laws, Sanctions	Certification, Accreditation	Common beliefs, Shared Logics of Action, Isomorphism
Affect	Fear, Guilt/Innocence	Shame/Disgrace	Certainty/Confusion
Basis of legitimacy	Legally sanctioned	Morally governed	Comprehensible, Recognizable, Culturally supported

Appendix 2: Names of research groups and their leaders in regenerative medicine research field

S.no	Name of the group	Institutional affiliation	Group leader	Number of researchers	Group's webpage
1	Eye	UTA	Heli Skottman Associate Professor	14	https://tinyurl.com/lmucje9
2	Neuro	UTA	Susanna Narkilahti, Docent, PhD	17	https://tinyurl.com/n4ocgqm
3	Adult Stem Cells	UTA	Susanna Miettinen, Docent, PhD, Associate Professor	19	https://tinyurl.com/mylebxq
4	Heart Group	UTA	Professor Katriina Aalto-Setälä, PhD	18	https://tinyurl.com/md36ncq

5	Biomaterials and Tissue Engineering	TUT	Prof. Minna Kellomäki (Dean)	NA	NA
6	Computational Biophysics and Imaging	TUT	Prof. Jari Hyttinen	21	https://tinyurl.com/l9jfhmo
7	Sensor technology and biomeasurement	TUT	Prof. Jukka Leikkala	NA	NA
8	Micro-and Nanosystem research	TUT	Prof. Pasi Kallio	NA	NA